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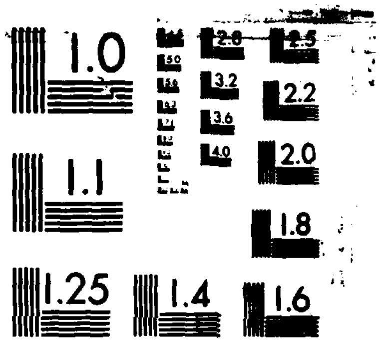

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A SEGMENT LEVEL STUDY OF DEFENSE INDUSTRY CAPITAL INVESTMENT

THESIS

Richard H. Searle
Captain, USAF

AFIT/GSO/ENS/85D-14

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This study examines the economic factors that are influencial for encouraging capital investment in the defense industry. A group of candidate variables are evaluated to select a set that best captures the variability of capital expenditures. The regression results indicate that defense contractors' liquidity, both profits and depreciation, is a major determinant of investment behavior. The results suggest that DOD profit policy should be changed to further encourage capital investment and that a special depreciation allowance would lower the cost of capital expenditures.

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A SEGMENT LEVEL STUDY OF DEFENSE INDUSTRY CAPITAL INVESTMENT

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Master of Science in Space Operations

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Abstract

This ~~study~~ thesis investigates the economic factors that are influential for inducing capital investment in the defense industry. The research focuses on the segment level of the firm in order to provide a more discriminating examination of defense industry behavior than would not be possible at the combined firm level. The firm segments chosen for the study are from companies that have remained among the largest 100 prime contractors between 1977 and 1984. A descriptive model is developed which includes a group of candidate variables that were chosen based on investment theory and previous empirical work. From the proposed model a set of variables is selected that best captures the variability of capital expenditures in the defense industry.

The results of the regression analysis indicate that liquidity is the most important factor for determining the level of capital expenditures in the defense industry. The level of output, as measured by sales, is also an important factor. Liquidity is the internal sources of funds available from profits and depreciation. The close relationship between liquidity and capital expenditures suggests that increased emphasis on capital investment as part of the weighted guidelines profit policy is appropriate. An additional measure available to encourage defense industry capital investment is the establishment of a special depreciation allowance that would increase liquidity and lower the costs of capital investment for the defense industry.

A SEGMENT LEVEL STUDY OF DEFENSE INDUSTRY CAPITAL INVESTMENT

I. Introduction

Background

In the last two decades, rising costs and lagging productivity in the defense industry have led to Defense Department efforts to encourage capital investment by defense contractors. Government action, intervention and incentives during World War II created a powerful defense industry that was capable of supplying the weapons and material for the Allied Nations. Following the war, this capacity to satisfy defense needs was converted to peacetime activities or eliminated. The meager post-war military requirements were insufficient to support the large production facilities that had been developed by the defense industry. Contracts fell by more than nine billion dollars immediately following Japan's surrender (4:24).

American industrial ability to respond to defense needs was still powerful in spite of the contract reductions, as demonstrated during the Korean conflict. The government money required to produce equipment and develop advanced technology weapon systems revived some of the large military contractors from World War II. The defense industry worked closely with the government on research and development efforts that yielded improved technology for new weapon systems. Jet engines, nuclear submarines, and missiles were developed through government cooperation with industry. Technical collaboration is required to ensure that

industry supports the technological innovations needed for new weapon systems (51:3). As this collaborative relationship strengthened, government spending and policy became more influential on the defense industry. When the defense budget began shrinking in 1969, military pay increases and an emphasis on scientific research and development caused a reduction in spending for manufacturing military equipment. Military systems had become increasingly more sophisticated and were being manufactured in smaller numbers that did not encourage developing cost saving production technology (18:21). In 1980 the average age of machine tools owned by the Department of Defense was greater than 25 years, with only 6.1 percent less than ten years old (1:2-5).

A decline in manufacturing technology was one of the factors that caused lower growth in productivity in the late 1960s. Countries with higher productivity growth rates invested more to modernize facilities and equipment. Among industrialized western nations from 1960 to 1976, the United States had the poorest record for investment and productivity growth. Older manufacturing equipment becomes less productive and operating costs increase because of a failure to take advantage of technology that saves labor and resources. Research and development had been important for industrial growth due to the productivity associated with developing new equipment, materials and industrual processes. In spite of this relationship, industrial research and development spending reached a maximum in 1969 that was not exceeded until 1978 (1:9).

The lack of industrial research and development spending was only one cause for sluggish productivity in the defense industry, and the situation became worse in the late 1970s. Defense industry response was

characterized by lengthening lead times for government procurement of subsystems and material. Some replacement equipment required up to two years for production (18:66). In addition to low productivity, the shrinking number of defense contractors slowed the response to Defense Department needs.

Lack of competition among defense contractors frustrates the operation of a free market. When only a very few sellers do business with the federal government, the price is often negotiated instead of being determined by market conditions. Gansler (18:42) provides ample description of the high concentration of sales by the largest four firms in different parts of the defense industry. In this market, characterized by high concentration, the government strives to establish effective competition to slow the rise in costs (51:2). In this concentrated market, the skill of government negotiators may not reduce the costs if commercial and foreign sales become more attractive to a defense contractor. While defense procurements dropped to a low of 17 billion dollars in the early 1970s, foreign military sales expanded to 14 billion dollars from 1.5 billion (18:26).

The Department of Defense is purchasing major weapon systems and services in a segment of the economy that is characterized by aging manufacturing technology, low productivity, and high costs. Recognizing this situation (52), the Defense Department has used the weighted guidelines profit policy to create an incentive for defense contractors to increase their investment in manufacturing equipment and facilities. This capital investment is intended to provide higher productivity and lead to lower costs for the Department of Defense.

Problem Statement

Previous studies (1; 50; 8) examined the effectiveness of the weighted guidelines profit policy to encourage defense industry capital investment. They either condemned the profit policy or recommended improvements, but they did not quantitatively show what factors encourage defense industry capital investment. Capital is defined for the purpose of this study as expenditures on fixed property, land, buildings and equipment. Capital investment is influenced by a number of factors. Collins (12) investigated the impact of financial factors like sales, assets and depreciation on capital investment in the aerospace industry. Barker and Konwin (4) studied the impact of intangible factors like management, quality and expectations in their firm based analysis. Knowledge of the specific factors that influence capital investment is important for improving Defense Department investment incentive policy.

Research Question

What economic factors are influential for inducing defense industry capital investment?

Research Objectives

The objective of the research is to investigate the performance of possible investment incentives in the defense industry. This research will be accomplished by investigating the following:

1. How did Department of Defense profit policy affect defense contractor profit in terms of return on sales and return on investment.

2. What were the effects on defense industry capital investment caused by the changes to the weighted guidelines policy.

3. What factors influence defense contractor capital investment.

4. What statistical model captures the interaction of the factors with capital investment.

Scope of the Research

This research is limited to examining the financial factors that can be obtained for the defense industry at the firm and segment level. A segment is a component of a firm that represents ten percent or more of the consolidated sales, operating profits, or assets (48:Ch2,2). The use of data from a segment is more appropriate than the firm level data because segments are the firm's business operating unit. Segment data permits a more discriminating examination of defense industry behavior than would be possible from the combined firm level data.

The majority of empirical studies of capital investment behavior are times series studies at the firm or industry level. Segment reporting has only been required by the Securities and Exchange Commission since 1977. Because of the limited number of years for which segment data is available, this study uses cross sectional analysis.

Methodology

Investigating the financial factors that effect capital investment in the defense industry is the goal of this research. The development of the Defense Department's profit policy provides insight for determining the factors that have been used to influence capital investment in the defense industry. Examining the literature concerning capital investment theory shows how previous models were developed, how they were organized, and what variables were used. This research involves developing a statistical model that captures the interaction of financial factors with capital investment.

A number of models are available from the field of statistical economics (34). This study uses concepts from many of these models to develop a set of variables that provide insight into capital investment in the defense industry. Regression analysis is used to compare the response of capital investment to changes in the selected variables. The regression model is used to examine the tendency of the dependent variable (capital expenditures) to respond to changes in the independent variables. Only a limited number of independent variables or financial factors can be practically used to describe the variability of capital expenditures due to software limitations. A central concern involves choosing the 'best' independent variables (42:371).

Standard and Poor's Compustat financial data base is the data source for this investigation. Financial data for the largest 100 defense contractors, measured by sales, is used to represent the defense industry. The Compustat data base was found to be comparable with the FTC data used in the Department of Defense study of defense contractor profitability and investment, Profit 76 (52:ChII,4)

Chapter II provides the policy development background and theory behind capital investment in the defense industry. The first part of the chapter examines the study effort that produced changes to the Weighted Guidelines Profit Policy. The changes in profit policy and criticism of the policy are also discussed. The second part of the chapter examines capital investment theories and models. A number of different theories are reviewed to provide a theoretical framework for the development of a descriptive model of capital investment in the defense industry. The model variables that are subsequently selected depend on

the support of capital investment theory as well as providing a practical means that relates to policy action.

Chapter III presents the methodology for the empirical investigation of capital investment at the segment level of defense industry firms. The regression model is presented and the variables are defined and justified based on previous empirical studies and capital investment theory. The Compustat data base is also briefly described. The last part of this chapter explains the criteria for selecting the defense industry firms whose segments are included in this study. The rationale for a cross-sectional study of defense industry segment data over three different time periods is also provided.

Chapter IV presents the analysis of the regressions used to arrive at the model that accounts for the variability of capital investment in the defense industry. The first part of this chapter describes the selection of the set of best independent variables used as a base-line model for studying the data sets of the two remaining time periods. The reasons for some variables' insignificance to the model's ability to account for variance in capital investment are discussed. The last part of the chapter statistically compares the results from the three data sets to determine if they represent the same or different relationships. The differences in the model's performance is discussed in economic terms to explain the underlying reasons for the changes in the different factors' relationship to capital investment.

The last chapter presents a summary of findings about the factors that impact capital investment in the defense industry. The conclusions

are discussed with recommendations about factors that can be used in policy action for encouraging defense industry capital investment.

II. Review of Literature

This chapter provides both the background of current Department of Defense investment incentive policy and a review of capital investment theories and models. In order to understand the development of current investment incentives, it is important to investigate the methodology used by the Department of Defense to determine what underlying relationships could be used to correct the undesirable trends toward higher costs and lower productivity. While the Defense Department relies on profits, the theories reviewed in this chapter offer a number of other determinants of capital investment. Econometric models are reviewed to show how the determinants of capital investment are measured and evaluated.

Defense Incentive Policy

This part of the literature review examines the profit-study report, referred to as Profit 76, the changes to the Department of Defense (DOD) weighted guidelines profit policy since 1976, and the follow-on study called Profit 82. The Profit 76 study group recommended the first change to the weighted guidelines in September 1976 in Defense Procurement Circular (DPC) 76-3. The second change was published in Defense Acquisition Circular (DAC) 76-23, in February 1980. The Air Force Systems Command conducted the follow-on study.

Profit 76. The purpose of Profit 76 was to determine defense contractors profit relative to nondefense companies in similar lines of business. It also examined the relationship of profit margins to investment in cost reducing equipment and facilities. The study was chartered by the Deputy Secretary of Defense in May 1975 and supervised by the

Assistant Secretary of Defense (Installations and Logistics) (52:Ch1,2). Profit 76 was undertaken because there were widely differing views on defense industry costs and profits. On one side of the debate, many members of Congress believed the high cost of weapons systems was the result of high profit margins for the defense industry. Higher return on investment figures for the defense contractors supported this view (45:17,18). On the other side of the debate, defense industry spokesmen complained of low profitability. Support for this was found in the lower return on sales for defense contractors, reported in Logistics Management Institute and General Accounting Office studies (52:Ch2,14). At the center of the debate was a growing concern over the costs of DOD procurement and how profit policy could be changed to reduce these costs. "Thus, the overall goal of our [DOD] profit study was to develop revisions in policy that would help achieve proper investment levels and associated reductions in costs" (52:vii).

The methodology of Profit 76 involved three separate studies. The first was a comparison of financial data from defense contractors and non-defense companies in similar lines of business. The results would provide information on sales, profit margins and capital investment. The second study was an opinion survey of government procurement personnel, which gathered information on the adequacy of defense contractor profit opportunity, the amount of incentive necessary to encourage capital investment, and policy impact on defense contractor productivity (52:ChI,6). The third study was an analysis of the weighted guidelines profit oblectives for 1975. Data from the forms used to establish the contracting officer's profit objectives prior to contract negotiations

were sampled to examine the distribution of profit under the weighted guidelines policy (52:ChV,1). Each of the three studies within Profit 76 is discussed along with the results.

The study team used data colelcted from 64 defense contractors representing 168 profit centers to compare the profit margins and capital investments of defense related and commercial businesses. This information was provided voluntarily by defense contractors. The data was reported to an independent accounting and management firm to preserve confidentiality and to ensure reliability and compliance with instructions. The intent was to establish a data set that could withstand close scrutiny by critics. Accordingly, not all submitted data was found acceptable. Data from the government profit centers was the primary source of defense contractor profitability information. A profit center is the smallest unit with a balance sheet and income statement. Limited data on profitability was also available from the commercial profit centers of the defense contractors, but the number of commercially oriented profit centers within defense firms did not make a reliably large enough sample. Federal Trade Commission (FTC) durable goods data was used as the primary source on commercial profitability. The FTC data base was the most comprehensive one available, representing about 5000 companies. The data covered 1970 through 1974. The FTC durable goods data was presented collectively as well as divided by product gorups (e.g., aircraft and missiles, electronics). The government profit center data was organized similarly but with slightly different product groups (aircraft, ships, missiles, electronics, and others).

The government profit center data was also grouped by the type of contract; fixed price and cost (52:ChII,3-11).

The ratio of profit before taxes to sales (return on sales) was consistently higher for the FTC sample than for the government profit centers. The five year average of the government profit centers was 4.7% or 2% below the FTC average (52:ChII,14). The product group return on sales figure required some interpretation because the groups reported by the government profit centers and in the FTC data did not match. For example, the five year average of return on sales by government profit centers for missiles was 6.1%, as compared to the FTC average of 4.2% for aircraft and missiles (one group). The FTC data for this group represents far more commercial aircraft sales than missiles and the comparison is therefore suspect for missiles. But the same FTC average of 4.2% return on sales is larger than the 3.7% government profit center average for aircraft (52:ChII,16). Divided by product groups the government profit center averages are less than the FTC averages except for missiles and less than the commercial profit center group averages in all cases.

A comparison of the average return on sales between fixed price and cost type contracts over five years showed only a 0.3% difference. The higher contractor risk involved in fixed price contracts was only slightly more profitable than the cost type contracts. This lack of discrimination indicated improper contract type selection where the additional risk was not rewarded (52:ChII,18). The difference between the average negotiated return on sales (8.8%) and the realized return (4.7%) showed an erosion of profits occurred during contract completion.

The reason for the erosion was not specified except that an average of 2% of the return on sales were not allowed by contracting officers in accordance with appropriate procurement regulations (52:ChII,20).

Return on investment (measured by profit before taxes divided by total assets minus progress and advanced payments) for the government profit centers was 13.5% while the FTC sample was 10.7%. The higher return for the government profit centers was first attributed to the amount of government-owned facilities that allow contractors to generate sales without the cost of the facilities and equipment reflected in their profits. But estimating the cost and depreciation as if the contractors owned the government-owned facilities only reduced the government profit center return on investment to 13% from 13.5% (52:ChII,25). It was apparent from the return on sales combined with the return on investment that the reason for the higher return on investment for government profit centers was due to less investment.

Assets to sales ratios confirmed the lack of investment. The study showed that FTC durable goods producers invested an average of 63 cents for every dollar of sales, while the defense contractors invested an average of 35 cents. The assets to sales ratio showed that the shipbuilding product group was the most capital intensive. The product group assets to sales ratios agreed with the overall averages (52:ChII, 31). The five year average of facilities capital to sales ratios showed that the FTC durable goods manufacturers invested "about 2-1/2 times as much as the government profit centers . . ." (52:ChII,3). The government profit center average was 10.9 cents invested in facilities for

every sales dollar, while the FTC data indicated 25.5 cents invested in facilities to support a dollar of sales.

To examine the interaction between facilities capital investment and return on sales, the study compared commercial profit centers (secondary data source) to the government profit centers to show the relationship between larger investment and larger return on sales.

> There is a rough correlation between the amount of investment a company is willing to make and the amount of profit dollars that the company can expect to realize. Investment in facilities takes money, and the amount of money that will be invested is somewhat dependent on the margin of profit dollars that will flow to retained earnings [52:ChII,35].

Due to the high risk in the defense industry, perceived by the financial community, equity funding was not available. The overall decline in the defense industry earnings combined with rising debt to equity ratios made debt financing unattractive. The defense industry was investing in capital at roughly the same rate as their depreciation and inflation was causing a net decrease in facilities investment. From this information the study team concluded that ". . . increased return on sales will help stimulate investment" (52:ChII,36).

The objective of the second part of Profit 76 was to confidentially survey government procurement personnel to determine what actions they thought would be effective for motivating defense contractor investment. The survey data consisted of 200 replies to the questionnaires that were handled by the accounting and management consulting firm. The average respondent to the survey was a civil servant with more than 15 years experience in procurement (52:ChIII,2). The technicalities of the survey are omitted in favor of reviewing the results.

The respondents felt that the previous government effort to increase contractor capital investment, DPC 107, failed because it did not encourage consideration of defense contractors return on investment and it was too complicated (52:ChIII,20). The procurement personnel indicated they believed there was a trend away from competition for defense contracts due to the complexity of procurement procedures, complicated administrative requirements and high risk. The respondents also indicated support for using the weighted guidelines for profit determination and allowing higher profit for contractor capital investment (52:ChIII,21).

The conclusions drawn from the survey in Profit 76 were that the majority of procurement personnel had an "adversarial" relationship with the defense industry and felt that their job was to reduce defense contractor profits. The study team further concluded that education and training would be required if a profit policy was to be effective at increasing defense contractor profits as an incentive for cost-reducing capital investment (52:ChIII,22).

The third part of Profit 76 was an analysis of the prenegotiation profit objectives, documented on DD Forms 1547 from July 1974 through December 1975. The analysis covered the profit factors referred to as Cost Input to Total Performance (CITP). These factors include materials, labor, overhead, and general and administrative costs that the contractor incurs while completing the contract. These cost factors are in addition to what is strictly required by the contract and they represent some of the areas where capital investment is reflected in government contracts. The data represented 535 negotiated contracts in excess of one million dollars (52:ChV,9). The results of the analysis showed that the profit

factors requiring the least capital investment were assigned higher profit objectives, within their allowable range. The results also indicated that average profit objectives were higher for low risk types of contracts. Profits were not being assigned correctly during contract negotiation.

Defense Procurement Circular 76-3. The information that had been gathered and analyzed led to the development of the revised DOD profit policy that was published in DPC 76-3 in September 1976. There was a fundamental assumption that it is possible to decrease DOD costs by encouraging capital investment with higher profits (52:ChVII,2). Profit 76 had shown the association of higher return on sales with higher investment for the FTC durable goods producers. The revisions to the DOD profit policy are summarized here and in Table 1 to show the emphasis given to contractor facility investment.

The first major change allowed the cost of financing facility investment (cost of capital) to be recognized as a normal cost for the contractor, to be included as a contract cost under Cost Accounting Standard 414. The second major change established a profit objective for the level of facilities investment, with a weight range from 6 to 10%. The revised profit guidelines also deemphasized cost as a basis for profit, to get away from the "cost plus percentage of cost" method of profit determination. Concurrent with this deemphasis was the wider profit ranges established for the different levels of contractor risk associated with different contract types. Cost plus fixed fee contracts, with the lowest risk, were allowed weights up to 1%, while the firm fixed

TABLE 1

Summary of Profit Policy Changes

Weighted Guidelines Profit Objectives	Before Profit '76	1976 DPC 76-3	1980 DAC 76-23		
	All Contracts	All Contracts	Manufacturing	R&D	Services
Contractor Effort:					
Direct Materials:					
Purchased Parts	1 to 4%	1 to 4%	1 to 4%	1 to 4%	1 to 4%
Subcontracts	1 to 5%	1 to 5%	1 to 5%	1 to 5%	1 to 5%
Other Materials	1 to 4%	1 to 4%	1 to 4%	1 to 4%	1 to 4%
Engineering Labor	9 to 15%	9 to 15%	9 to 15%	9 to 15%	N/A
Engineering Overhead	6 to 9%	6 to 9%	6 to 9%	6 to 9%	N/A
Manufacturing Labor	5 to 9%	5 to 9%	5 to 9%	5 to 9%	N/A
Manufacturing Overhead	4 to 7%	4 to 7%	4 to 7%	4 to 7%	N/A
Services Labor	N/A	N/A	N/A	N/A	5 to 15%
Services Overhead	N/A	N/A	N/A	N/A	4 to 8%
G&A Expense	6 to 8%	6 to 8%	6 to 8%	6 to 8%	6 to 8%
Adjustment Factor	N/A	(30% of effort)	(30% of effort)	N/A	N/A
Contractor Risk	0 to 7%	0 to 8%	0 to 8%	0 to 7%	0 to 4%
Facilities Investment		6 to 10%	16 to 20%	N/A	N/A
Record of Performance	-2 to 2%				
Selected Factors	-2 to 2%				
Special Factors:					
Foreign Military Sales	1 to 4%	1 to 4%			
Independent Development	1 to 4%	1 to 4%	1 to 4%	1 to 4%	N/A
Productivity		*	*	N/A	N/A
Other		-5 to 5%	-5 to 5%	-5 to 5%	-5 to 5%

* The Special Productivity Factor was to be the cost decrease multiplied by the base profit rate

Source: Profit Study '82

price contracts, with higher cost risk were allowed weights between 6 and 8% (52:ChVII).

Increased productivity would be rewarded with a small profit factor that reflects the cost savings. Previously, cost reductions resulting from increased productivity would reduce the contractors basis for payments and profits on current and subsequent contracts involving the methods of improved productivity. There was a disincentive for contractors to improve productivity because payments and profits were tied to costs. Higher costs yielded higher profits. Recognizing this disincentive, the special productivity factor was created to prevent defense contractors from suffering a loss due to increased productivity. The special productivity factor was computed from the cost decrease multiplied by the contracts base profit rate. The application of the special productivity factor required a follow-on contract and presentation of reliable cost data showing the cost reduction (52:ChVII,24).

Past performance was eliminated as a profit factor because it had been subject to wide variations in measurement. And finally, to avoid an overall increase in price resulting from the additional profit weighting factors, the relative weight of the contractor effort portion was reduced from 65% of total profit to 50% (52:ChVII,9). This maintained the same total profit weight while shifting emphasis to productivity and capital investment.

Defense Acquisition Circular 76-23. Following three years of experience with the revised weighted guidelines profit policy, the Department of Defense concluded that the policy was not adequately encouraging capital investment by defense contractors. The guidance was not clear

enough for assigning profit weights to contract cost risk. There were too many research and development (R&D) and services contracts that were not compatible with the weighted guidelines "manufacturing oriented" approach (38:Ch7,1).

DAC 76-23, published in 1980, was intended to adjust the weighted guidelines profit policy. Because the incentive to increase cost reducing investment had been inadequate, the weight range for facilities investment was increased to 16-20%. To clarify the guidance for contract types and their associated cost risk profit factors, separate profit ranges were established for manufacturing, R&D, and services contracts (see Table 1). Accordingly, the weights for each type of contract were differentiated to reflect contract risk.

Profit 82. The purpose of the Profit 82 study was to evaluate the effectiveness of the changes to the weighted guidelines profit policy. The study team from the Air Force Systems Command attempted to reproduce the methodology of Profit 76. The purpose was to use similar methods to evaluate the impact of DPC 76-3 and DAC 76-23. The main objective of the study was to determine the effectiveness of the policy revisions to encourage investment in cost saving facilities by defense contractors (50:1).

Unable to obtain updated government profit center data, the study team used the contracting officers reports of individual contract profit plan (DD Form 1499) for 1977 to 1981. These reports are maintained by the Air Force and other government agencies and represented 1,760 contracts totalling more than 11 billion dollars (50:1). A review panel of government and industry professionals in the area of contracting and

acquisition criticized the reliance on profit plan reports but the study team felt that the reports were an adequate data base.

> We agree individual reports represent contracting officer's perceptions of negotiated profit; however, we used the entire universe of DD Form 1499 data over a five-year period. We believe these data in the aggregate, represent valid profit trends. Furthermore, since this data base has been used previously by DOD to formulate profit policy, we believe our use of the DD Form 1499 data is both valid and consistent [50:14].

These reports provide sufficient data to reproduce the planned profit objectives but do not reflect the "realized" profit information reported in Profit 76. Profit 82 compared the DD Form 1499 data to the FTC published data on the commercial sector for the same time period.

The data showed that the five year average of return on sales for the FTC durable goods producers had increased to 6.9% from 6.7%. The DD Form 1499 data showed that the contractor negotiated return on sales had increased to 10.6% from 8.8%. By subtracting the contractor profits that are disallowed by the contracting officer during contract completion (typically 2%), the five year average contractor return on sales was estimated at 8.6% (50:15). The study team compared these increases and concluded that defense contractor profits increased more than the FTC sample. The reason was attributed to the shift in contract types, which provided higher profitability than during earlier time periods (50:21).

The Profit 82 study team compared the negotiated profit by contract type for the period 1977 to 1981 with the period 1970 to 1974. Slight changes occurred in all the average profits. Average negotiated profit for firm fixed price contracts increased 2%, fixed price incentive increased 1.5%, cost plus incentive fee increased 1%, and cost plus fixed

fee increased 0.3% (50:14). This information still deals with "negotiated" profit and suffers a certain remoteness from reality while indicating a slight trend. The distribution of profit objectives had caused a change in the contract types that were negotiated after Profit 76, starting in 1977. Contractor effort, risk, and facilities investment had all changed their relative profit weights but the contract risk factor was most significant. Application of the special productivity factor represented 11% of the profit increase while 21% of the profit increase was due to the change in the use of contract types (50:16-23). The use of higher cost risk and higher profit fixed price contracts increased faster than the lower risk contracts.

The study also included a procurement personnel survey similar to that in Profit 76. An analysis of the trends in contract officer profit assignment was also conducted. This analysis investigated the performance of the weighted guidelines profit policy using the same reports of individual contract profit plan. Profit Study 82 also evaluated the profit factors that were not included in the weighted guidelines prior to 1976, like special productivity.

The results of Profit 82 generally agree with the findings of other evaluations. (34,3,44) The assumption that profit was the most effective incentive for capital investment was not adequately supported by the results.

> Although it [profit] is an important factor in capital investment decisions, it does not rank as high as other criteria. By far the greatest concern to the industry is the expectation that the capital investment would be fully recovered, including a reasonable return. Other important criteria are competition, maintaining market shares, growth, technological advancement, etc. [49:53].

The profit rewards for capital investment in DPC 76-3 were too small to be an incentive and DAC 76-23 further reduced the investment incentive.

In DPC 76-3 the facilities investment profit factor applied to manufacturing, R&D, and service contracts. The profit range for facilities investment was 6 to 10% and this was intended to represent up to 10% of the total profit. In DAC 76-23 the facilities investment profit range was increased to 16 to 20%, in an attempt to increase the investment incentive. But at the same time the contract types (manufacturing, R&D, and services) were separated to clarify the assignment of the contractor risk factor. As part of the separation, the facilities investment profit factor was applied only to manufacturing. Assuming the intention of the profit policy was to encourage investment only in manufacturing this action makes sense but it had wider impact. The distinction between contract types reduced the incentive for capital investment due to the large amount of capital (estimated at 37% of total corporate assets) assigned to engineering cost pools, which are often heavily involved in R&D contracts (50:35).

Another finding of Profit Study 82 dealt with the failure of the special productivity factor. It was not used due to the difficulty in measurement and was generally not applied to all the contracts which benefitted from increased productivity. There was confusion by procurement personnel as to the application of weighted guidelines profit policy and some doubt about the credibility of the guidelines for determining profit (50:55).

A study completed in 1984 (38) repeated part of the analysis of Profit 82 by using the same data base. The conclusion of this study was:

"Neither DPC 76-3 nor DAC 76-23 induced capital investments in cost reducing facilities and equipment." The comparison of average data showed that defense contractor assets had increased 28% from 1980 to 1982, but concluded that the increase was a result of the Accelerated Cost Recovery System tax change in 1981 and not due to DOD profit policy. This conclusion was supported by the increase in assets for government profit centers (28%) and FTC durable goods producers (29%) at a faster rate than sales (20% and 14% respectively) from 1980 to 1982, while sales increased faster in the previous period (38:Ch7,9). The significance of depreciation had been pointed out earlier by Paek (43). With depreciation based on the acquisition cost, inflation causes a widening gap between the cost recovered and the replacement cost of capital. The shorter time for cost recovery under the new tax system encouraged capital investment.

The policy revisions resulting from Profit 76 were based on the assumption that increased profits stimulate capital investment. While the commercial sector had both higher profits and higher capital investment, a cause and effect relationship was never established. It was not shown how reduced costs from defense industry capital investment would be passed on to the government without relying on a cost-based profit policy. The cost-based profit policy was an original disincentive for investment because increased productivity from investments reduced defense contractors' basis for profit. The Defense Department is also applying other approaches to encourage investment, examples are multiyear contracting and the defense industry technology modernization program.

A defense contractor assumes a substantial risk by investing in facilities and equipment for a government contract. If the contract is not renewed for the next year the contractor is burdened with the investment and its financing. The B-1 bomber is one example, but it was eventually revived under a new contract for the B-1B. Multiyear contracting was allowed and encouraged by DOD as part of the Carlucci Initiatives to reduce procurement costs (51).

The defense industry technology modernization program (TechMod) is an experimental program started in 1982 to develop contract incentives for capital investment. The program provides a framework for the evaluation of different incentives and will provide a well documented information base for developing future investment incentive policy.

> The incentives, which include contractor investment protection and shared savings, among other rewards, are aimed at overcoming two primary problems: program uncertainty and a profit policy which is based on cost. In the first instance, the problem is that risks are introduced which hinder investment amortization and inhibit long-term planning. In the case of the cost-based profit policy, a contractor may actually see profits reduced as a result of efforts to improve productivity and hold down costs [45:42].

The Profit 76 study seemed to imply that the determinant of capital investment in the defense industry is profitability. Return on investment (Facilities Investment) is used within the weighted guidelines as part of the overall profit in a government contract. The lack of explicit reference to a theory of investment seems odd when there are so many from which to choose. Is the defense industry so unique that investment theories or models are not applicable? The next two sections of this study review some of the available theories of investment and some of the modeling methodologies that have been applied to capital investment.

Capital Investment Theories

Capital theory is different than capital investment theory. Capital is the physical assets of production; land, facilities and equipment. Capital theory is an explanation of the level of capital and capital investment theory is an explanation of the rate of change in capital toward a desired level. Investment requires the sacrifice of present income in favor of future income. The accelerator theory of capital investment explains the change toward the optimal level of capital as proportional to the level of output. The underlying relationship is the acceleration principle, where "investment expenditures depend on the rate of change of consumption outlays" (37:12). This process of adjustment was refined to provide for a gradual correction of the level of capital that proportionately reduced the difference between the actual level of capital and the desired level. The adjustment process includes a distributed lag function that incorporates the different past levels of output into the explanation of the rate of change in capital (39:261).

The methods of financing capital investment provide an alternative to the accelerator theory's dependence on output or sales levels as the determinant of the optimal level of capital. The liquidity theory explains investment behavior in terms of expected profits. A potentially profitable investment is more attractive and more easily financed if the firm has funds available for the investment. The availability of internal funds is the measure for determining capital investment. Sales levels are joined by profits in a linear relationship that is generally caused by a rigid price behavior in the manufacturing sector (38:262). The causal relationship between sales and profits would suggest that sales

are the determinant of profit but profit is the source of funds for investment. Given a standard for dividend payment, profits can be used as an investment determinant. Higher profits lead to higher levels of internal funds, which lead to more capital investment (39:263). Expected profits from the investment are then related to current profits.

Jorgenson (31) supports the neoclassical theory of capital as the appropriate explanation of investment behavior. An important distinction is made that the neoclassical theory describes demand for capital not demand for investment. Using the neoclassical theory to examine investment behavior requires applying a lag function to the changes in the desired level of capital and adding the effect of replacement investment, in order to isolate the change in the level of capital. The lag function describes the time required to translate a change in the desired level of capital into a change in the actual level of capital stock. According to neoclassical theory, the desired level of capital maximizes the net worth of the firm. Replacement investment is a proportion of the current level or stock of capital. The desired level of capital is proportional to the value of output divided by the cost of capital goods.

Maximizing the net worth can be restated as maximizing the present value of the firm. The investment decisions made by a firm under neoclassical theory are based on maximizing the present value of the future stream of income that flows from an investment. The demand for capital is based on choosing a production plan that maximizes the present value of the capital services (32:135-138). This can be viewed as choosing to acquire capital along a production possibilities curve that represents maximum present value. The consumption of the capital and its services

is accomplished to maximize utility for capital and labor, given the goal of maximizing the present value of the firm.

Jorgenson and Siebert (33) describe four different theories of capital investment in their comparison of corporate investment behavior theories. The theories of investment behavior in this study are: accelerator, expected profits, liquidity, and neoclassical. The comparison of these theories was undertaken because past studies had not presented adequate discrimination between the performance of the different theories.

The key to comparing the theories appears to be the development of the lag structure that describes the time pattern required by individual firms to adjust changes in desired capital into changes in actual capital. The flexible accelerator mechanism developed by Chenery and Koyck (11) is used as the common specification for the lag structure (33:681-683). The flexible accelerator mechanism addresses the change in capital stock, defined as total investment less replacement investment. The change in capital is proportional to the difference between the desired level of capital, K^*, and the actual level of capital, K.

$$K_t - K_{t-1} = (1-\lambda)\ (K^*_t - K_{t-1}) \qquad \text{(EQ1)}$$

The distribution of the lag adjustment (λ) is chosen to discriminate between the different theories because each has a unique method for determining the desired level of capital.

> Misspecification of the lag distribution for a given theory of investment behavior may bias the results of our comparison. Accordingly, we choose the best lag distribution for each alternative specification of desired capital from among the class of general Pascal distributed lag functions. Differences in the resulting explanations of investment behavior may then

> be attributed to the specification of the desired level of capital rather than to the specification of the lag distribution [33:688].

In the accelerator theory of investment the desired level of capital is proportional to the level of output (33:685). This theory of investment is supported by Eisner (15,17), where output is expressed as sales. In the expected profits theory the desired level of capital is determined by profit expectations. The measure of profit expectations is studied by Grunfeld (20) and he maintains that the appropriate measure is not current or past profits but the market value of the firm. The market value of the firm is measured by the value of outstanding stock plus the book value of debt.

> An advantage of the "value of the firm" as an explanatory variable of investment behavior lies in the fact that it measures the result of a complex market mechanism that tries to achieve essentially the same goal as ourselves, namely, to summarize and evaluate all the information that is relevant to the future demand conditions of the firm's product and the supply conditions of its factors so as to obtain a reliable forecast of its future profits [20:225].

In the liquidity theory of investment behavior the desired level of capital is determined by the funds that are available to the firm for investment. Liquidity refers to a firm's cash position, and it can be measured by internal funds as income after taxes plus depreciation. In the comparison of investment theories, candidate measures of liquidity included gross operating profit. The measure of liquidity used in the comparison was profits after taxes plus depreciation less dividends. The results of using this measure of liquidity agreed with earlier work by Kuh. The desired level of capital is expressed as a proportion of the liquidity of the firm (33:685,694).

The neoclassical theory of investment was used in two forms for the comparison. One version included capital gains and the other did not. The neoclassical theory as described above "implies a theory of the cost of capital" that determines the investment decisions that maximizes the present value of the firm. The cost of capital used here is a weighted average of the expected return on stockholders equity and the expected return on debt (33:685-686). The underlying cost of capital theory was developed by Modigliani and Miller (41). The cost of capital is determined by the present value of future income that flows from the capital. This present value must be greater than the cost of financing the investment in capital. The capital can be financed by selling equity in the firm as common stock or by incurring debt. The investment then must provide a stream of income that satisfies stockholder expectations for a rate of return and provide an after-tax income that meets the debt requirement. In the two versions of the neoclassical theory used in the comparison, the capital gains was included in one of the calculations of the expected return on stockholders equity.

The different theories were tested using a representative sample from the largest industrial corporations listed in the Fortune 500 Directory. The results of the regressions indicated that the neoclassical theory (with and without capital gains) best explained investment behavior. The expected profits theory was the next best, followed by the accelerator and the liquidity theories.

The comparison of investment theories reviewed above did not fully explain the development of the cost of capital theory. This theory was developed to provide a basis for rational decision making concerning

investments in an uncertain environment. The cost of capital theory developed by Modigliani and Miller (41) provides a more realistic view of the factors that impact investment decisions within a firm. They criticize the assumption that a single market rate of interest can be equated to the marginal return on physical assets to determine the level of investment. This cost of capital theory also permits the calculation of the cost of capital from commonly reported financial data (40).

The capital of a firm provides a stream of income over time. Assuming that the firm lasts forever, the stream of income is an infinite series that consists of the return on assets which are not constant over time. An average value can be used to express this return, subject to a probability distribution (41:265). In order to apply the cost of capital, it was assumed that firms could be divided into "risk" classes where all firms within a class had the same expected return on assets. The development of this idea was presented such that initially all capital assets are owned by corporations and their only method of financing capital is by issuing stock. The rate of return on assets becomes a return on shares. Within each risk class the return on shares is equal. The price of these shares is determined by the risk class of the firm and the expected return on shares. The expected rate of return within the risk class is also constant (41:265-267). This rate of return is referred to as the market capitalization rate. For any firm in the same class, a capital investment must produce a stream of income that meets or exceeds the expected rate of return on the stockholders shares.

The theory is developed further by including the effect of debt. Debt tends to change the market perception of a firm even though moderate

debt does not change the firm's risk class. To address this problem, all debt from firms in the same class payed the same rate and were substitutable for any other debt within the class. The market value of a firm in any given class is the sum of the value of outstanding shares plus its debt. With the above assumptions, the market value of a firm within any class is independent of its debt structure, instead relying on the market value (41:268).

The market capitalization rate is now the amount or present value of the income stream divided by the market value of the firm. This market capitalization rate is also referred to as an "average cost of capital" (41:268). The yield (rate of return K) on a share of stock is equal to the capitalization rate (a), "plus a premium related to financial risk equal to the debt-to-equity ratio (D/V) times the spread between the capitalization rate and the interest rate (r)" (41:271).

$$K = a + (a - r)(D/V) \qquad \text{(EQ2)}$$

The development of the cost of capital theory was expanded to include the effects of corporate taxation (41:272). The corporate tax allows the recovery of part of the interest payed against the firm's debt. When the corporate tax rate (t_c) is considered, the yield on stock becomes:

$$K = a + (a - r)(1 - t_c)(D/V) \qquad \text{(EQ3)}$$

If the yield on stock is known, the market capitalization rate can be determined. The market capitalization rate is the average cost of capital. If the different tax effects for equity, debt, and retained

earnings are individually applied to the market capitalization rate, the cost of capital for each method of financing capital investment can be caluclated.

Modelling Methodologies

The econometric models in the literature generally follow one of the previous theories of capital investment. The modelling efforts often differ in their selection of a lag function and the method used to represent or measure the determinants of capital investment (6,33). The differences in lag functions are not reviewed here. Instead, this review of modelling methodologies will focus on the selection of variables used to support the different theories of capital investment. The economist is not necessarily tied to a particular statistical method, but almost all the modelling involves showing the relationships between factors in a generalized production function. The measures of correlation from least squares regressions are well suited for demonstrating a statistical relationship such as this and are almost always used in the modelling of capital investment behavior.

The accelerator model is based on the relationship between investment and changes in output. Expectations about future output are based on the past levels or changes in sales. The basic accelerator model uses only output as the determinant of net investment. Net investment does not include the replacement of existing capital which is generally assumed to be proportional to the level of capital assets. The adjustment of capital toward the desired level is accomplished incrementally as described by the appropriate lag function (34:193).

In one formulation of the accelerator model, Eisner (16) used sales and changes in profits as determinants of investment. The level of capital stock was included to determine the replacement investment. Changes in profits are used to represent the changes in the expected profitability of investment. The sales and changes in profits data were obtained from the Securities and Exchange Commission-Federal Trade Commission Quarterly Financial Report (16:193-194).

Eisner (17) also applied improvements in the consumption function to improve earlier empirical results of the accelerator model. The improved consumption function was based on the hypothesis that consumption is a "stable function of 'permanent' income and that its relation to 'measured' income is an unstable proxy relation which depends upon . . . variances of observed and permanent incomes" (17:238). He used this relationship to show that investment is a stable function of "permanent" changes in output. Eisner maintained that earlier empirical results were flawed due to unstable proxy variables including large elements of transitory changes in output. This "permanent acceleration hypothesis" implies that firms will invest to the extent that they believe the increases in output represent a permanent increase in demand (17:237-240). Increases in sales will result in increased investment because they represent demand, but the investment will not reflect what the firm considers transitory changes in sales. Profits were included in this model to investigate their influence as a proxy variable for expected future demand.

The liquidity model uses the flow of funds available to the firm as determinants of investment. The flow of funds include profit and

depreciation. The current and past flow of funds act as a proxy for expected profits. This mdoel is similar to the expected profits model because the expected profits are the determinants of investment. An advantage of the liquidity model is that it directly addresses the factors that limit capital investment. The cost of financing capital investment increases when the internal sources of funds are exhausted and the firm goes to outside sources of financing (i.e., debt or equity markets) (6:16,19). In the previously cited comparison of capital investment theories (33), the liquidity model was the least successful and this might explain its lack of popularity in capital investment literature. The same variables used in the liquidity model do show up in connection with other investment models. Anderson (2) uses profits, non-capital assets, and interest rate as variables in a model that is generally based on neoclassical theory. The non-capital assets are government securities. His model successfully captured the impact of output, the cost of capital, capital stock and liquidity.

The expected profits model uses the market value of the firm as the determinant of investment because it acts as a measure of expected future profits. In Grunfeld's investigation of the determinants of investment (20), the model included the market value of the firm and the current level of capital. The market value of the firm was measured by adding the market value of outstanding shares of common stock to the book value of debt.

Grunfeld was concerned with the inferior nature of profit as an "explanatory variable." He pointed out the importance of allowing for the impact of existing capital in the expected profits model because

profits can act as an incentive to invest if they exceed the normal return on existing capital (20:217). He maintained that current profits are not a good measure of expected profits and expected profits do not always act as an investment incentive. Profits can be realized as a result of unexpected conditions or as a result of past investments. If the profits are unexpected and the cause is seen as transitory, there is no reason to expect capital investment to occur. If the profits were the expected normal return on past investment there would also be no reason for current capital expenditures (20:215).

Lagged net sales for the preceding four years were used to reflect demand forces in an expansion of Grunfeld's investment model (19). Adding the lagged net sales value did not improve on the correlation provided by the original two variables for the period studied by Grunfeld (1934-1954). The expanded model performed better than the original with data for the years 1955-1960. Neither model was a very good predictor in the latter period mainly due to changes in the stock market in the late 1950s (19:315-316). The market value of the firm variable performed poorly as the stock market changed. The net sales variables were able to describe more of the variability of investment. This implies a need for variables that capture economic trend information in time series studies, as well as variables that express the determinants of investment.

The neoclassical model includes the value of output, the cost of capital, and the level of capital stock as the determinants of investment. The cost of capital is included in many of Jorgenson's formulations of the neoclassical model as an implicit rental price of capital

services (33,34). The rental price of capital services depends on the price of investment goods (an index), the cost of capital (calculation), and the tax structure. The value of output was measured by sales plus the change in inventory stock. The capital stock was available from balance sheet information (33:695).

While much of the literature on capital investment models involves variations on the four investment theories presented above and in Table 2, there are exceptions that generally embrace simpler formulations. The most common feature of these "other" models is that they appear to be specialized studies that are concerned with examining capital investment once. The model's durability is not a goal of the study, instead a relationship is examined.

An example that applies to the current literature review was an investigation of the effects of inflation related factors upon suppliers to the government and the Air Force (5). Among the models developed in this study, three investigated investment behavior. The dependent variables were the gross replacement ratio, net replacement ratio and the capital change ratio. The gross replacement ratio was defined as capital expenditures divided by assets. The net replacement ratio subtracted depreciation from capital expenditures then divided by assets and the capital change ratio was capital expenditures divided by depreciation. The purpose of studying these fairly unique dependent variables was to examine the impact of sales to the government on capital management in the aerospace industry (5:66). The regression results struggled unsuccessfully for statistical significance.

TABLE 2

Capital Investment Theories and Models

Name	Determinants	Measures
Accelerator	Output	Sales
Expected Profits	Expected Profits	Market Value of the Firm Value of Stock Debt
Neoclassical	Output Net Worth	Sales Cost of Capital
Liquidity	Expected Profits	Profits Depreciation
Other	Combined	All of the Above

A study by Collins (12) of industrial responsiveness in the aircraft industry also included a model of capital investment. This study examined the financial and economic trends for eight leading aircraft and parts manufacturers. It was limited when investigating capital expenditures at the segment level because the eight corporations only represented 13 aerospace segments. The independent variables in the segment level study were return on sales, return on assets, government sales percentage, and capital expenditures to sales ratio (12:19). Collins also used aerospace industry data from 1966 to 1979 in simple linear regression to show that order backlog was the best predictor of the capital investment trend in the aerospace sector (12:11).

Many of the concepts and determinants of investment discussed in this literature review are applied to the development of the model that follows. The capital investment model developed in this study attempts

to determine what set of economic factors are most influential to defense industry investment. The candidate variables are chosen from those available in both the theory and modelling of capital investment.

III. Defense Industry Capital Investment Model

The purpose of this research is to investigate the factors that influence capital investment at the segment level in the defense industry. This chapter describes the development of a model that provides insight into defense industry capital investment. The characteristics of the selected data base are also discussed. The dependent variable of the model is capital expenditures at the segment level. The independent variables include net sales, assets, depreciation, order backlogs, sales to the government, market value of the firm, cost of capital, capital output ratio, return on investment, return on sales, and sales-investment ratio. The purpose of examining these variables is to select a set that best captures and explains the variation of capital expenditures in the defense industry. The proposed model is presented here:

$$CAPX = f(NSAL, ASSET, DEP, BLG, GSL, MKT, COC, COR, ROI)$$

Capital Expenditures (CAPX)

The dependent variable in this model represents the capital investment by the firm to support operations at the segment level. Capital expenditures are the funds used for additions to property, plant, and equipment, excluding the amounts that arise from acquisitions (48:ChV,18). The exclusion of capital acquired through acquisition permits examination of the capital assets acquired for expansion or replacement. It is assumed that replacement capital not only replaces worn out equipment but improves the production process through modernization. It is this kind of modernization that the Defense Department is concerned with, in

order to increase productivity in the defense industry and lower the costs to the government.

The dependent variable expresses gross investment, which accounts for the growth in capital as well as the replacement of existing capital. Many of the models discussed above are concerned with the change in capital and isolate the effect of replacement investment. They examine the determinants of net investment. The current study examines the factors that effect capital investment expenditures because they represent the modernization of facilities and equipment.

Net Sales (NSAL)

The net sales variable indicates the size and output of the segment. While investigating the effects of inflation related factors upon suppliers to the government and the Air Force, Beverly (5:71) used sales as a size variable. Sales is also a measure of output, which is not inconsistent with its use as a measure of activity or size. Based on the acceleration principle, capital stock should vary proportionately with output, because the rate of change of output is one of the determinants of investment demand. As sales levels increase, the demand for investment increases proportionately. The increase in sales indicates an increase in demand for the product, which provides both the incentive to invest and a potential source of funds for the investment. The increase in output should represent a permanent change in demand in order to result in a change in investment (17:240).

From neoclassical theory, the planned change in capital stock is typically assumed to be equal to some proportion of the difference between desired capital stock levels and current levels (33:683). A

difficulty in applying this to defense contractors occurs because the desired level of capital stock is highly dependent on the number and duration of contracts awarded to the firm. The desired level of investment is directly effected by contract awards because a defense contractor is not encouraged to make capital investments prior to the contract award.

The use of net sales as a measure of size and output is intended to capture some of the variability of capital expenditures that results from the increased level of demand for capital stock. Net sales are defined as gross sales less cash discounts, trade discounts, and credit allowances given to customers (48:ChV,16).

Assets (ASSET)

The asset variable also captures the impact of segment size. A larger segment should have a greater capability to make additions to plant and equipment than a smaller firm, all other things being equal. The asset variable is obtained from Compustat data where it is named "identifiable assets" and defined as tangible and intangible assets that are directly associated with each segment (48:ChV,18). Intangible assets are patents, trademarks and copyrights. Their cost is assigned against the product with which they are associated. Tangible assets include land, buildings, machinery and equipment (10:430).

A size variable is better expressed in terms of assets rather than sales or employment because it provides an indication of both the physical and monetary capability of the firm. Additionally, changes in sales variables may act as a proxy for the rate of growth of a firm's capital stock. An increase in sales can be a product of investment and

growth rather than a precursor (14:789). Larger firms are able to undertake investments more easily than smaller firms (44:107). This ability stems from operations that strive for economy of scale and because larger firms have a broader access to sources of finance for investment.

Investment in new capital and replacement of existing capital are both reflected in capital expenditures, the dependent variable of this model. The replacement effect is more dependent on the current stock of capital, its age, utilization, and profitability. The requirement for replacement capital increases as a proportion of the existing capital, while net investment is not as closely related to the current level of capital assets. Investment in new capital, as net investment, is a function of the difference between the desired level of capital stock and the current level (20:217). Investment in new capital and replacement of existing capital are both important to this investigation of defense contractor behavior because they contribute to the Defense Department objectives of modernization and cost reduction.

Sales Made to the Government (GSL)

The purpose of including sales to the government as a variable is to investigate its association with capital investment in the defense industry. The results of the Profit 76 study indicated that FTC durable goods producers invested more than twice the amount per sales dollar as defense contractors (52:Ch2,36). The Profit 76 study compared the relationships of profit, assets, sales, and investment and concluded that sales to the government were not as profitable and that defense contractors generally did not invest as much as the FTC durable goods producers due to profits.

The current model investigates the determinants of investment in a more direct manner. The amount of sales made to the government is included here to examine whether changes in sales to the government are associated with changes in capital expenditures.

Due to the "winner takes all" nature of defense industry contracting, government contractors would not be expected to make significant capital investments prior to contract award. For this reason the government sales variable is expected to have a positive sign. Collins' study (12) of industrial responsiveness in the aircraft industry included results contrary to this expected relationship. Using a statistically small sample of 13 industrial segments, Collins concluded that the segments with the lowest percentage of government business directed capital expenditures into their defense related product lines at a higher rate than the segments with higher percentages of government business (12:23). This contradiction might be due to the companies reacting to increased demand or attempting to expand their market share for their defense related products or "expansion investment to qualify for contract consideration" (4:119). Beverly was unable to show the statistically significant impact of government sales until he reduced his examination to the manufacturing firms with standard industrial classification codes between 3000 and 4000 (5:78). The amount of government sales is available from the Compustat industry segment file.

<u>Capital Output Ratio</u> (COR)

The capital output ratio is used in this model to measure the capital intensity of the segment. Capital intensity expresses the relationship between the assets used in production to the sales dollars they

generate. A capital intensive segment has large amounts of assets tied to its production process either due to the nature of the industry (like shipbuilding) or due to inefficient production, or both. The capital output ratio is defined as assets divided by net sales.

The amount of government owned facilities can skew the results of ratios like capital output, particularly when comparing segments that vary in government facilities used. Collins' study of the aircraft industry demonstrated wide variations (30 and 40% higher than average) in return on assets in the aircraft engine segment and space and missile segment (12:23). A firm is in a better position to make a profit if part of its production assets are provided by the government. A firm with significant government owned facilities might be more able but less willing to invest in new plant and equipment if the older government owned facilities would be the limiting factor in achieving efficient production rates (12:16).

Return on Investment (ROI)

Profitability can be expressed in a number of equally important ways. In evaluating the possibility of additions to capital stock, return on investment is significant among the factors influencing the investment decision (22:96). The expected return on investment is therefore the real value for which current return on investment is a proxy. Return on investment is defined for the industry segment as operating profit divided by capital expenditures. Operating profit is the sales amount minus the share of operating costs and expenses for the segment (48:ChV,17). This definition of return on investment differs from the normal: profits divided by capital assets. The use of capital

expenditures in the denominator is intended to capture the profitability of current investments, rather than measure the return on assets acquired in the past. An investment decision is based on the marginal difference between the expected cost of the investment and the expected present value of its future income. This measure of return on investment is more sensitive to changes in profit and is used to evaluate the profitability of newly acquired capital.

The results of Eisner's model of the investment function showed small positive regression coefficients for the previous year's profits for within-group and overall regressions. These profit results may encourage those who, unlike Eisner, support profits as a determinant of investment. Profits may not totally determine investment behavior but at least the timing would be influenced by recent profits (17:246). The Defense Department uses profits as an incentive to encourage contractor capital investment in order to achieve lower costs through improved productivity and efficiency. The DOD support of profit as an incentive tool is explained in Armed Forces Procurement Regulation 3-808.1.

> It is the policy of the Department of Defense to stimulate efficient contract performance. Profit generally is the basic motive of business enterprise. The government and defense contractors should be concerned with harnessing this motive for more effective and economical performance [12:7].

Because of the significant role that return on investment assumes in determining the total profit in contract negotiations (12:22,52:Ch7,3), it is important that its impact on capital expenditures be reflected in this model. The weighted guidelines profit policy relies heavily (20%) on profit for facilities investment. If the return on investment is a strong determinant of investment then this variable should be significant in this model.

Return on Sales (ROS)

The significance of profit in the defense industry was further stressed by the findings of the Profit 76 study: "increased return on sales will help stimulate investment" (52:Ch2,36). Return on sales at the segment level is defined as operating profits divided by net sales. The current model evaluates the influence of return on sales on capital expenditures compared to return on investment. To separately evaluate return on sales and return on investment, the model must take on two different forms.

The return on sales is not directly comparable to the return on investment. Both are measures of profitability, but can be misleading when compared. With a given level of investment establishing a production process; a low profit per item and high sales volume results in low return on sales and high return on investment. Conversely, a high profit per item and low sales volume results in high return on sales and low return on investment. In 1978 the Lockheed Corporation return on sales was 38.4% less than the aerospace industry average. While at the same time Lockheed's return on investment was 56.7% more than the industry average (45:17). The correlation of return on sales to capital expenditures is important for further evaluation of the Defense Department profit policy. This demonstrates the need to control for the level of sales by adding the sales-investment ratio to the model that includes return on sales.

Sales-Investment Ratio (SIR)

The sales-investment ratio is intended to account for the systematic differences in segment operations that cause the different profit

figures to be misleading, as in the Lockheed example. Return on investment can be expressed as the product of return on sales and the sales-investment ratio. ROS and SIR interact to determine the profitability of capital expenditures. This is similar to the Du Pont system of financial analysis, where return on investment is determined by combining the effects of return on sales and the turnover ratio of investment. The turnover ratio is sales divided by total assets. So the return on investment is the profit for the total assets of the firm (53:152). The sales-investment ratio variable is defined as net sales divided by capital expenditures.

Market Value of the Firm (MKT)

This variable follows from Grunfeld's investment model where gross investment is a function of the market value of the firm and the current level of capital stock. Market value was represented by the sum of the market value of outstanding shares and the book value of outstanding debt. The market value of the firm acts as an expectational variable for explaining changes in investment (20:224-226).

Capturing the expectations for the firm is important to this model because capital expenditures are based on future needs for capital services. Current size and output are relevant to the investigation of capital investment but their impact on capital expenditures may largely reflect replacement activity. Profit may be a "surrogate variable" for future expectations. The market value represents the expected profit that is reflected in the value placed on the firm by the securities market (20:211). This variable is defined as the sum of the value of common shares outstanding and the total debt of the firm. The market

value of the firm variable is not available at the segment level so the value will be applied to the segments of the appropriate firm according to the segment's percentage of the firm's sales.

Cost of Capital (COC)

The cost of capital is an important part of the capital investment decision. The corporate leadership is assumed to compare the current price of a capital investment with the present value of the stream of future earnings that the investment would produce. This stream of operating profits is discounted by the cost of the capital. The discounted present value of the earnings must be greater than the expense of the investment or the value of the firm is reduced or the net profit of the firm is reduced (41:262). The cost of capital can arise from debt financing, stock issue, or the use of retained earnings, or some combination thereof.

The cost of capital is a deterrent to capital investment when interest rates are high enough to prohibit debt funding or make stock offerings uncompetitive. Interest rates reached a peak in 1980 and although rates have fallen they may still be high enough to dissuade capital investment decisions in the defense industry (36:Ch3,33). Initially, a simple proxy for the cost of capital was considered. The prime rate of interest was considered as a general rate for the cost of capital, because the rate of interest measures the market cost of raising funds through debt issue (2:416). This would have been too broad a measure and would assume that the firms studied could obtain the base rate for prime customers of large money center commercial banks. The use of a simple proxy like an average interest rate also infers that the defense industry

cost of capital is based solely on debt financing. The conclusions of Profit 76 (52:Ch2,36) indicate that this is not likely and initial analysis of the data for this study indicates a 31% average of debt financing for the defense industry firms.

The cost of capital variable used in this study estimates the weighted average of the cost of capital for debt financing, stock issue, and retained earnings. This method for estimating individual firm's cost of capital allows for inter-firm differences based on empirical data rather than a single market characteristic like the prime rate of interest.

The weighted average of the cost of capital can be estimated if the market capitalization rate for the firm can be determined. The market capitalization rate can be estimated from the anticipated annual percentage increase in dividends and from the discount rate that represents the expected return based on stockholders' expectations. The expected dividend growth rate (g) can be estimated from the following equation:

$$(\text{earnings per share,year } 1)(1+g)^{10} = (\text{earnings per share,year } 10)$$

The rate of growth of past earnings is used instead of dividend growth because it provides a better description of anticipated dividend growth. This allows for changes in the dividend payout ratio that would cause an underestimation if the growth was based on dividends while the company's annual earnings grew (40:100,101).

If the investing public expects an annual increase in dividends (g), then the discount rate (K) is the figure "used to evaluate that growing stream of payments" and explains the current market price of the firm's stock (40:102). The discount rate (K) can be calculated as

$$K = (d/P) + g \qquad \text{(EQ4)}$$

where (d) is the current dividends per share and (P) is the current stock price. The discount rate (K) for the investing public in Eq (4) can be applied to Modigliani's expression in Eq (3) for the rate of return (K):

$$K = a + (a - r)(1 - t_c)(D/V) \qquad \text{(EQ3)}$$

Solving this equation for (a) produces an estimate of the market capitalization rate for the firm based on the long term debt (D), the market value of the common stock (V), the average interest rate paid (r), and includes the impact of corporate taxation (t_c) (40:94). The market capitalization rate is the average cost of capital. The corporate tax rate for this calculation is assumed to be 50% for simplicity.

The cost of capital for equity, retained earnings, and debt can be determined by applying their particular finance structure to the market capitalization rate. The cost of capital for equity (Re) is the market capitalization rate corrected for the cost of issuing new stock:

$$Re = a/(1-b) \qquad \text{(EQ5)}$$

The value of the denominator corrects for the cost of a new stock issue, where (b) is the percentage difference between the existing price of common stock and the net proceeds realized from a current sale (40:72). The underwriting and legal expenses of corporate bond offerings are small in comparison to the amount of funds raised and might be ignored. On the other hand, a stock offering includes the cost of the investment banker and the price discount to the existing stock that must be applied in order to rapidly sell the new issue. The value of the difference (b)

in the current model is 10% which is within the range suggested by Lewellen (40:46).

The cost of capital financed with retained earnings (Rr) is the after-tax rate of return for the firm which considers both the personal income tax rate of the stockholder (t_p) and the capital gains rate (t_g):

$$Rr = a(1 - t_p)/(1 - t_g) \tag{EQ6}$$

This rate of return represents the funds available to a stockholder if a distribution of earnings had occurred. This calculation artifically assumes that a stockholder would pay the capital gains tax at the end of the first year (40:62-68). Research cited by Lewellen (40:73) into the average tax rate for a common stockholder indicated that a 35% marginal bracket was appropriate at the time. The marginal tax bracket used for the average stockholder in this model (t_p) is 40% and has been adjusted upward from the value used by Lewellen to compensate for "bracket creep" caused by inflation. Trials using different tax rates showed the weighted average cost of capital is not sensitive to changes in this range. Based on a capital gains taxation at 40% of the personal income tax rate, the marginal income tax rate implies an average capital gains rate of 16%.

The cost of debt financed capital (Rd) is the required after-tax return on the investment:

$$Rd = a(1 - t_c) \tag{EQ7}$$

The above relationship was derived with the assumption that debt was the only source of financing. Later in the development of the cost of debt

capital model it was assumed that after a firm started borrowing it would continue with the debt level because it represents an optimal level of return based on the deductibility of interest charges (40:41-44). The formula for the cost of debt capital does not include the interest rate because the required rate of return on debt funded investment is determined by the risk class of the firm and the corporate tax rate (41:268).

The weighted average cost of capital is determined by weighting the costs of the three methods of finance (Re, Rr, Rd) shown in Eqs (5), (6), and (7), with the percentage of each finance method (equity (Xe), retained earnings (Xr), and debt (Xd)) used by the firm:

$$COC = (Xe)(Re) + (Xr)(Rr) + (Xd)(Rd) \qquad \text{(EQ8)}$$

This formulation of the cost of capital (COC) can be accomplished using data from the Compustat Business Information Service.

Depreciation (DEP)

The depreciation variable is a measure of liquidity and represents expected profits that are associated with capital expenditures. The variable includes depreciation, depletion and amortization and "represents non-cash charges for obsolescence and wear and tear on property, allocation of the current portion of capitalized expenditures and depletion charges for the industry segment" (48:ChV,18). Depreciation is the assignment of the acquisition cost of capital assets against the income they produce. A percentage of the income from capital assets is recovered to offset their cost. Depletion is the cost of removing natural resources for their use in production. Amortization is the

assignment of the cost of acquiring intangible assets such as patents, trademarks and copyrights (10:432).

Cost Accounting Standard (CAS) 409 is the Defense Department depreciation policy that applies to contractors. It does not require any one specific method of depreciation although it was intended to standardize depreciation practices. CAS 409 was also intended to standardize the income tax treatment and financial reporting practices of defense contractors, but it has been misused to the point of bypassing the requirements of the Federal Accelerated Cost Recovery System (ACRS). The Cost Accounting Standards Board no longer exists, so there is no agency responsible for policing these practices (36:Ch3,19). The different accounting practices among firms could introduce variability in the relationship between depreciation and capital expenditures.

While Kaitz found no support for the motivating force of the ACRS and CAS 409 on contractors to increase capital investment, he maintained that these policies would have a positive impact on contractors' ability to invest because of their increased cash positions (36:3,20). The impact of the ACRS and CAS 409 after 1980 could help contribute to the generally increased investment trend shown in the new plant and equipment expenditures reported by the Aerospace Industries Association of America (36:Ch3,2).

Liquidity is indicated by the internal funds available for investment expenditures and is measured by profits after taxes plus depreciation. The depreciation variable in this model measures liquidity but does not include profits because they are already represented in the ROI and ROS variables. The inclusion of profits in this liquidity measure would

obscure the effect of depreciation and repeat similar information.

Backlog (BLG)

The backlog of orders for a firm or its segments indicates demand in excess of current capacity. If this demand is perceived to be more than transitory it can result in capital investment. "Order backlog is the dollar amount of orders believed to be firm for the industry segment, as of the end of the company's fiscal year" (48:ChV,19). In this model, backlog is an expectational variable that represents anticipated demand. In the work done by Collins (12), backlog was the best predictor of capital investment in the aerospace sector. The connection between anticipated demand and the establishment of capital requirements for the segment depends on the perceptions of the corporate leadership. If the increase in order backlogs is perceived to be transitory there is no reason to make investment expenditures. Additionally, if a segment or firm is operating at less than full capacity, the order backlogs may result in an increase in the level of employment of the idle factors of production without an appreciable increase in capital expenditures.

Data Characteristics

This study of defense industry capital investment is focused at the segment level of the firm to provide better analysis than can be accomplished using consolidated corporate information. Studying the firms that account for the largest sales to the government and examining their investment behavior at the segment level should provide a clearer picture of the determinants of investment in the defense industry. All data for this study comes from Standard and Poor's Compustat Services, Inc.

Using the Compustat Business Information File provides information on each operating segment of a consolidated corporation.

The Industry Segment File is the second of three subset files within the Business Information File. The primary sources of segment data are Annual Reports to Shareholders and 10K reports, which are required by the Federal Accounting Standards Board and the Securities and Exchange Commission. Reporting has been required since 1977 for segments which account for ten percent or more of the consolidated firm's operating profits, sales, or assets (48:ChII,2). The Industry Segment File contains up to 11 data items for each segment along with sales data on principle products and principle customers (48:ChV,15). The data items are: net sales; operating profits; depreciation, depletion, and amortization; capital expenditures; identifiable assets; equity in earnings of unconsolidated subsidiaries; investments at equity; employees; order backlog; customer and company sponsored research and development.

The data required for estimating the cost of capital (COC) and the market value of the firm (MKT) is obtained from the Compustat Annual Industrial File because it relates specifically to the balance sheet information available only for the consolidated corporation. The primary sources of Industrial File data include Annual Reports to Shareholders, 10K reports, reports from the National Association of Securities Dealers Automated Quotations (NASDAQ) and Interactive Data Services, Inc., Dow Jones News Service, and Standard and Poor's Publications (48:ChII,5). The Industrial File provides 175 annual data items that include income statement, balance sheet, and financial position information.

Standard and Poor's Compustat Services carefully validates the data it obtains from the various sources. The input data is "spot checked" against the original source documents. The new data is compared to computer generated statistics for the industry to identify inconsistencies requiring further examination. The data is also examined for errors related to omission or duplication that can be detected by comparing totals and subsets of the data (48:ChII,9).

The time periods covered in this study correspond to the changes in Defense Department profit policy. The changes to the weighted guidelines profit policy were published in September 1976 and February 1980. The data is averaged for the three year groups covering 1977 to 1979, 1980 to 1982, and 1983 to 1984. The averages of the financial data for these three periods is used to eliminate noise caused by single year variability. The three year groups also represent different economic periods. As indicated by gross national product figures (46:432), the first year group was a period of slowing economic growth, the second time period was a recession, and 1983 and 1984 were years of economic recovery.

The defense firms whose segments are included in this study were selected from the 100 companies with the largest sales of prime contracts to the Department of Defense (23-30). The firms not related to manufacturing were eliminated (e.g., oil companies). Foreign and non-profit firms were also eliminated. Those firms that remained in the "top" 100 from 1977 through 1984 were used for the analysis.

Plots were made of each independent variable against capital expenditures to determine the functional form of the relationships and as a means to detect outlier observations. All independent variables were

found to be linearly related to capital expenditures. Some of the segment data was far beyond the range of the majority of segments (more than three standard deviations). These outlier observations badly distorted the characteristics of the data. These segments were from very large manufacturing firms like Ford, General Motors and IBM or were at the other extreme with extraordinary losses in profits with low sales. Generally, these segments had profits, sales and assets that differed by an order of magnitude from the rest of the segments. Removing these segments did not significantly change the regression equations or reduce the available data but it did significantly reduce the variance of the error terms.

Removing outliers is a sensitive operation, but the action is justified when inferences obtained from the reduced data are applied only within the range of observations (42:75). The inclusion of outlier observations distorts and disguises useful information that is available from the data. The reduced average data for first year group included 130 segments from 34 manufacturing firms. Using the same procedure for the remaining two sets of averaged data yielded 116 segments from 37 firms for 1980 to 1982 and 102 segments from 35 firms for 1983 and 1984.

The plots of the independent variables against capital expenditures indicated that the asset variable was highly correlated with capital expenditures (R^2 = .9931). This correlation was due to the fact that capital expenditures measure the change in assets. In this case the dependent variable is assets and capital expenditures measures the change in assets. Recognizing the association is valid, the model is

misstated. The asset variable was dropped from the proposed model because size is also measured by sales.

Investigating the impact of government sales (GSL) on capital expenditures was restricted by the reporting method in the Compustat data. Many firms combined their government sale data from all their segments and repeated the same number for each segment. For this study there is no information value in a firm government sales figure applied indiscriminately to all segments. Government sales was used only for those firms reporting unique values for each segment. Due to this restriction the study of government sales is accomplished using a subset of the overall data. The two data sets are statistically different and inferences concerning the effect of the government sales variable must be tempered with this knowledge.

The examination of data characteristics has caused some changes to the originally proposed model. The misstated asset variable has been eliminated. In order to compare the impact of return on investment to that of return on sales, different versions of the model are used:

$$CAPX = f(NSAL, DEP, BLG, MKT, COC, COR, ROI)$$

$$CAPX = f(NSAL, DEP, BLG, MKT, COC, COR, ROS, SIR)$$

A third proposed model is required to allow for the effect of the level of government sales. This requirement is caused by the reduced data available for segment level government sales.

$$CAPX = f(NSAL, DEP, BLG, GSL, MKT, COC, COR, ROI)$$

IV. Analysis

The purpose of the analysis presented in this chapter is to show which variables in the proposed models form the set that best accounts for the variability of capital investment in the defense industry. The analysis of the regression results shows how the best independent variables are selected from those in the models proposed in the previous chapter. The statistical and economic reasons for not selecting variables is also discussed. The resulting base-line model is then applied to the remaining two data sets. The regression results for all three data sets are compared to examine their similarities or differences. In particular, the question of whether the base-line model applies to the other data sets is answered by comparing the regression equations. This comparison will demonstrate whether the relationship established between capital expenditures and the selected variables of the base-line model is maintained in the following time periods.

Proposed Model Evaluation

Each of the three proposed models was run against the first data set, the three year average data for 1977 through 1979. Two important items became apparent from the regression results. The first item is the high degree of correlation between some of the independent variables. The second is the significance of the variables in each model.

Correlations Between Variables. The high degree of correlation between independent variables indicates their tendency to increase and decrease together because they are related to each other or to a common third variable. The correlation between the independent variables can

be caused by a common variable that is included or missing from the model. The correlation indicates that the variables repeat information to a certain extent. This relationship between independent variables is referred to as multicollinearity and is not unusual in business and economics. The measures of correlation in each of the proposed models are shown in Tables 3, 4, and 5. There are a number of possible reasons for the multicollinearity in these models.

Sales (NSAL), depreciation (DEP), and the market value of the firm (MKT) are all highly correlated in the proposed models and are related to the size and financial strength of the firm or segment. The size of a company or its segments is easily measured by sales or assets, or both. The amount of depreciation is dependent on the amount of assets and the rate of depreciation. Financial strength is reflected in the stock price used in calculating the market value of the firm. The stock price summarizes the market perceptions of the firm's strength and its ability to somewhat efficiently employ assets to produce income. It is not surprising to find that size and the market value of the firm are related. This association is not meant to equate large size and financial strength but to suggest that they are often present together. The high correlation between NSAL, DEP, and MKT is associated with the size or assets of the segments.

A number of studies (13,21,44) have shown a relationship between size, financial strength, and profitability. The collinearity in these models might also occur due to a common relationship with profits or profitability. Sales and depreciation are sources of funds for a firm, external and internal. Put simply, if sales are higher than operating

TABLE 3

Correlation Matrix of First Model
For 1977-1979

CAPX = f(NSAL, DEP, BLG, MKT, COC, COR, ROI)

	NSAL	DEP	CAPX	BLG	MKT	COC	COR	ROI
NSAL	1.0000							
DEP	.6373	1.0000						
CAPX	.6512	.9557	1.0000					
BLG	.3376	.0314	.0047	1.0000				
MKT	.6724	.5867	.5623	.0958	1.0000			
COC	.0099	.0609	.0885	.0236	.1689	1.0000		
COR	-.0116	.2908	.3569	-.2517	.0211	.1235	1.0000	
ROI	-.0954	-.2730	-.3170	.0549	-.0415	-.1217	-.4291	1.0000

TABLE 4

Correlation Matrix of Second Model
For 1977-1979

CAPX = f(NSAL, DEP, BLG, MKT, COC, COR, ROS, SIR)

	NSAL	DEP	CAPX	BLG	MKT	COC	COR	ROS	SIR
NSAL	1.0000								
DEP	.6373	1.0000							
CAPX	.6512	.9557	1.0000						
BLG	.3376	.0314	.0047	1.0000					
MKT	.6724	.5867	.5623	.0958	1.0000				
COC	.0099	.0609	.0885	.0236	.1689	1.0000			
COR	-.0116	.2908	.3569	-.2517	.0211	.1235	1.0000		
ROS	-.1676	-.0552	-.0171	-.1995	.0885	-.0537	.1505	1.0000	
SIR	-.0683	-.3145	-.3957	.2384	-.2002	-.1176	-.4805	-.3558	1.0000

TABLE 5

Correlation Matrix of Third Model
with Subset Data For 1977-1979

CAPX = f(NSAL, DEP, BLG, GSL, MKT, COC, COR, ROI)

	NSAL	DEP	CAPX	BLG	GSL	MKT	COC	COR	ROI
NASL	1.0000								
DEP	.6372	1.0000							
CAPX	.6878	.9709	1.0000						
BLG	.4405	.0829	.0735	1.0000					
GSL	.2856	.1732	.2313	.3642	1.0000				
MKT	.7615	.6778	.6853	.2688	.3097	1.0000			
COC	-.0114	.0232	.0368	.1842	.2745	.2125	1.0000		
COR	-.0020	.2334	.2459	-.2102	-.1876	.0156	.0713	1.0000	
ROI	-.0696	-.2439	-.2660	.0662	-.0408	-.1026	-.1807	-.2984	1.0000

costs, a stream of income results. Depreciation is the charge against income, before taxes, that reflects the cost of the equipment used in production. But depreciation is a non-cash charge, the firm does not pay out the amount of depreciation. The amount of depreciation becomes an internally generated source of funds for the segment.

Correlated independent variables can cause problems for interpreting the regression results. Multicollinearity indicates that the regression coefficient of any correlated variable depends on which other correlated independent variables are included in the model. These regression coefficients do not indicate any unique effect of the particular independent variable. Instead, they indicate a marginal or partial effect depending on which other correlated variables are used in the model (42:252). On the other hand, correlation between independent variables does not prevent the development of a regression model with a good fit. Multicollinearity also does not tend to prevent inferences concerning mean responses or predictions about new observations, "provided these inferences are made within the region of observations." (42:341) The region of observations is made up of the combined ranges of values covered by each independent variable. A basic restriction of multiple regression is that estimates or predictions based on a certain region of observation may not be applicable outside that region. This restriction is acknowledged and has been previously mentioned.

<u>Significant Variables</u>. The significance of the estimated coefficients provides a preliminary view of the variables that have the most impact on the level of capital investment and are most likely to form the final model. The regression results of the two proposed models using

the complete data set for the first year group are shown in Table 6. The Net Sales (NSAL) variable is positive and significant in both proposed models. This was expected as it measures the output level and size of the segment. It tends to agree with Eisner (15,16) by relating capital investment to changes in sales, which represents anticipated demand for output. A large, active firm would undertake more capital investment than a smaller or less active firm.

Depreciation (DEP) is also significant and positively related to capital expenditures in both models (Table 6, Eqs (9) and (10)). The depreciation variable is used in the proposed models as a measure of liquidity and the regression results indicate that liquidity is strongly related to the level of a segment's capital expenditures. Where capital investment is some proportion of the difference between the current and desired level of capital plus replacement of existing capital, the desired level of capital is proportional to liquidity (33:694).

The estimated coefficient of the BLG variable is negative in both proposed models and is significant in only the first (Table 6, Eqs (9) and (10)). The negative sign does not reflect the expected relationship. BLG is the measure of order backlogs and is expected to be positively correlated with capital expenditures. Order backlogs should stimulate capital investment provided they are not perceived as transitory. Order backlogs indicate demand in excess of current output. These results are also contrary to previous work (12) concerning the importance of order backlogs. When BLG was run individually against capital expenditures, using the averaged data for the same first year group, the coefficient was positive. This indicates that the negative sign is caused

TABLE 6

Initial Multiple Regression Results For 1977-1979

(Eq9)

NSAL	DEP	BLG	MKT	COC	COR	ROI
.01036	1.52624	-.00460	-.00936	56.50464	13.54869	-.67568
(3.788)	(32.719)	(-1.719)	(-1.186)	(1.175)	(2.918)	(-1.100)
*****	*****	**			****	

$\overline{R}^2$ = .9259 N = 130

(Eq10)

NSAL	DEP	BLG	MKT	COC	COR	ROS	SIR
.01158	1.513	-.0033	-.0154	60.8101	9.3895	16.0014	-.1792
(4.291)	(24.284)	(-1.279)	(-1.944)	(1.301)	(2.067)	(.739)	(-2.925)
*****	*****		**	*	***		****

$\overline{R}^2$ = .9313 N = 130

(Eq11)

NSAL	DEP	BLG	MKT	COC	COR	ROI	GSL
.01374	1.44823	-.0097	-.0151	53.2257	4.9192	-.5353	.01506
(4.490)	(23.516)	(-3.164)	(-1.363)	(.802)	(1.046)	(-.822)	(2.750)
*****	*****	****	*				****

$\overline{R}^2$ = .9573 N = 76

Parameter significance levels are (one tailed t test): ***** = 0.0005; **** = 0.005; *** = 0.025; ** = .05; and * = 0.10

Regression relation significance levels are 0.001 (F test)

by an interaction with other variables. What explains the apparent insensitivity to order backlogs?

The first explanation is that much of the defense industry does not operate at full production capacity, instead operating at a level of capacity that provides for some capability to expand when demand increases. The extra capacity is explained as a requirement for mobilization or wartime surge in production. The selected level of operation might be associated with a production rate that satisfies an average demand based on past experience. The segment is able to expand to a somewhat larger capacity after a period of time in which order backlogs have remained high enough to justify using the idle plant and equipment. The activation of idle capacity in response to government demand has been used repeatedly by defense contractors to avoid the cost of continually maintaining the factors of production at full capacity. Although sometimes the cost of maintaining the extra capacity has been allowed in overhead costs of government contracts (18:56). These factors of production include facilities, equipment and labor. This action would soften the impact of order backlogs on capital investment.

Another possible explanation is that the defense industry perceives order backlogs as transitory in general. The firms whose segments are included in this study are familiar with Defense Department procurement procedures and are sensitive to the lack of lengthy commitments in the form of multi-year contracts. These firms are also aware of the possibility that a contract that is intended to be renewed for subsequent years can be cancelled. With few multi-year contracts and high risk associated with capital investment, the lack of sensitivity to order

backlogs is not that surprising.

The order backlogs may be a normal feature of the defense industry where procurement requirements routinely exceed the capacity of the segment. Once a contract has been awarded there is no further need to expand production capability because future demand for the product may be limited by budget constraints or eliminated by technological advances. A defense contractor is able to determine the limitations of the product market and evaluate the future demand. Many weapon systems have a well known and finite production schedule with a follow-on system under development by a different firm while the current system is still in production. The current level of output for a defense contractor may have no relation to future demand.

The capital-output ratio (COR) is positive and significant in both proposed models (Table 6, Eqs (9) and (10)). The capital-output ratio is a measure of capital intensity for the segment. These regression results for COR are similar to those of Beverly's study (5:72), where the capital-output ratio was a minor determinant of investment. Capital intensity normally would be related to capital expenditures, particularly considering the effect of replacement investment. A capital intensive segment would tend to replace worn equipment at a faster rate than a less capital intensive segment. The correlation between capital intensity and capital expenditures in the defense industry is consistent with the economy as a whole, where replacement investment has dominated capital expenditures since 1919 (33:682).

The market value of the firm (MKT) has a negative estimated coefficient in the two proposed models that were studied using the full data

(Table 6, Eqs (9) and (10)). MKT is significant only in the second proposed model. The level of significance for MKT is less than most of the other variables whose estimated coefficients are significant which suggests that the MKT variable may not be selected during a stepwise regression. The sign of the coefficient is not as expected. The MKT variable was positive when individually run against CAPX, which indicates that the negative sign is caused by interaction with other independent variables.

The estimated coefficient of the cost of capital variable (COC) is positive in both proposed models (Table 6, Eqs (9) and (10)) but significant only in the second model where return on sales (ROS) and the sales-investment ratio (SIR) are used instead of return on investment (ROI). The positive sign of the estimated coefficient tends to indicate that higher costs of capital encourage capital expenditures. This might suggest that capital expenditures are made in anticipation of continued increases in costs. But the relatively low level of confidence in the second model suggests it may be in error. A more reasonable interpretation of the results would suggest that the defense industry is generally insensitive to changes in the weighted cost of capital. This interpretation would be consistent with Kaitz's (36:ChV,7) contention that the defense industry operates in a "welfare" environment that bases profits on cumulative costs. Instead of profits resulting from a return on risk they are a return on costs that ensure a level of fairness and the continued participation of defense firms in the market. In this environment, the cost of capital would not be a major determinant of capital investment as discussed by Modigliani (41).

Return on investment (ROI) and return on sales (ROS) were not significant in either of the proposed models (Table 6, Eqs (9) and (10)). These results are important when the Department of Defense uses return on investment as an incentive to encourage capital investment (52:ChVII, 6). A previous study by Kovich (38) concluded that profit incentives during this same time period had been ineffective for encouraging capital investment in the defense industry. The profit goals associated with defense contractor capital investment had not been reached, falling 3.6% short of the goal of 10% profit weight for facilities investment (38: Ch6,4). The Kovich study used a DOD data base of contracting companies and the average return on sales before taxes (9.1%) compares favorably with the mean value of return on sales data used in evaluating the proposed model in this analysis (9.5%). Both figures are an increase over the Profit 76 return on sales value of 4.7% for the five year average of 1971 to 1975 (52:ChII,14). The study compared the changes in averages and indicated that changes in capital investment were made by the defense industry in order to maintain a constant ratio of their facilities and equipment to their costs (38:Ch6,9). These conclusions would support the regression results and indicate that return on investment or sales are not very effective determinants of investment.

The insignificant results for ROI and ROS agree with Eisner's argument (17:242) that current profits are not a good indicator of future demand. If expectations of future profits motivate capital investment, current rates of return do not appear to be related to the resultant investment.

The sales-investment ratio (SIR in Table 6, Eq (10), is significant and has the expected negative relation to capital expenditures. The negative sign results from the dependent variable in the denominator of the sales-investment ratio. The SIR variable was entered into the model in order to investigate if the true relationship between capital investment and return on investment was due to an underlying correlation between return on sales and capital investment. If an increase in SIR is associated with a decrease in capital investment, it means that sales are either increasing or remaining nearly constant. The sales-investment ratio is present to correctly describe the components of return on investment. The SIR variable provides no unique information.

The regression results for the proposed model that allows the inclusion of government sales uses a subset of the data. The results of the initial regression are also presented in Table 6, Eq (11). The significant variables include NSAL, DEP, BLG, and MKT. In addition to these, the government sales variable (GSL) was singificant. The negative sign of the MKT coefficient is due to interaction with other variables. When this proposed model was run with the reduced data but without controlling for the level of government sales the results were different than the ones for the larger set of data. NSAL, DEP, and BLG are significant, but cost of capital is significant (0.10) when government sales are not included. This substitution of MKT for COC occurs because GSL is more correlated with MKT.

The results shown in Table 6, Eq (11), for the proposed model with GSL suggest that segments with more government sales have more capital expenditures. This conclusion is contrary to the results of Kovich's

study (38:Ch6,8), where FTC data indicated a 44% increase in total assets while government contractors reported a 27% increase.

Based on the sample set for this model, the level of government sales is a significant factor and positively related to the level of capital expenditures. Given the significance of GSL in the first data set, it is likely to remain in the model and its reliability can be checked in the later time periods.

Stepwise Regression Results. The model developed in this part of the research was produced by using the Stepwise Regression Program available from BMDP Statistical Software (8:251). From the proposed model the program selects the variable that contributes most to the explanation of the variability of the dependent variable. At each step, an independent variable is added to the model in the order of its additional reduction in the remaining unexplained variability of the dependent variable. The F statistic indicates whether the slope of the coefficient is zero when an independent variable is included. The magnitude of this statistic determines the entry order of the variables. This statistic is recalculated during each step to include the effect of the variables already entered into the model. These steps continue until very little additional explanation can be gained by adding an independent variable (8:251; 42:382). The best set of independent variables can be determined by applying the proposed models to the stepwise regression program.

The results of the stepwise regression confirmed the results of the multiple regression. The best set of independent variables in each proposed model are shown in Table 7, along with the increase in correlation provided by the variable. Neither return on investment nor return on

TABLE 7

Stepwise Regression Results

(Eq12)

NSAL	DEP	COR		$\bar{R}^2$	N
.0074	1.5329	17.7224		.9265	130
(.0063)	(.9557)	(.0068)			

(Eq13)

NSAL	DEP	COR	SIR	$\bar{R}^2$	N
.0079	1.4917	11.7114	-.1915	.9657	130
(.0055)	(.9134)	(.0037)	(.0100)		

(Eq14)

NSAL	DEP	BLG	GSL	$\bar{R}^2$	N
.0107	1.0490	-.0095	.0140	.9586	76
(.0081)	(.9427)	(.0037)	(.0042)		

Regression relation significance levels are 0.001 (F test)

Values in parentheses are the increase in R^2

sales is significant in describing the variability of capital expenditures in this representation of the defense industry. An important result of the stepwise regression is that the information provided by the second model (Table 7, Eq (13)) duplicates that of the first model. The sales-investment ratio (SIR) provides no unique information. Neither return on investment nor return on sales is significant in describing the variability of capital expenditures in this representation of the defense industry. The first two proposed models provide the same information concerning the financial factors that influence capital expenditures. The second proposed model is now eliminated from further investigation.

The model presented in Table 7, Eq (12), indicates that capital expenditures (CAPX) are primarily a function of depreciation (DEP), net-sales (NSAL), and the capital-output ratio (COR) of the segments:

$$CAPX = f(NSAL, DEP, COR) \qquad (EQ12)$$

The depreciation variable measures the liquidity or internally generated cash flow of the segment. The net-sales variable measures the size and output of the segment. The capital-output ratio measures the capital intensity of the segment. The baseline model indicates that capital expenditures are primarily a function of liquidity, output, and capital intensity.

The model that includes the government sales variable (Table 7, Eq (14)) indicates that capital expenditures (CAPX) are primarily a function of depreciation (DEP), net-sales (NSAL), government sales (GSL), and order backlog (BLG):

$$CAPX = f(NSAL, DEP, BLG, GSL) \qquad (EQ14)$$

The net-sales variable accounts for more of the variability of capital expenditures than the government sales variable. The government sales data represents the level of government sales for each segment of those companies that reported the amount separately by segment. The stepwise regression results suggest that the level of government sales is mildly associated with the level of capital expenditures. A segment with more government sales tends to make more capital expenditures.

The sign of the BLG variable is negative due to interaction with the other variables in the model. The significance of BLG is due to the

differences in the two data sets. To investigate the model's performance using the reduced data set and without controlling for the level of government sales, the proposed model in Table 6, Eq (9) was run with the reduced data. The regression results indicated the BLG variable was significant at a confidence level of 0.99. It is difficult to support the significant influence of order backlogs when a larger data set indicates an insignificant relationship. Additionally, the reduced data was examined to see if the distributions of the variables were similar to the complete set of data. The reduced data set was distributed in such a way that outliers were capable of distorting the relationships. From these comparisons, it can be concluded that any inferences made from the model concerning Eq (14) should be limited to the influence of the level of government sales on capital expenditures.

The high correlation between capital expenditures (CAPX) and depreciation (DEP) in all three models raises the question of some underlying connection between the two. The definition for the depreciation data in the Compustat manual (48:Ch5,18) was not sufficiently detailed to detect any connection between the data items. The depreciation definition indicates that the data is the value of the non-cash charges for obsolescence, wear and tear on segment property. The definition of capital expenditures also fails to indicate an interconnection. The author called Standard and Poor's Compustat Service in Denver requesting that a service representative research the question of an unstated connection. Mr. Gary Barwick provided the information that no connection existed, accounting or otherwise. The value of the depreciation is directly associated with capital expenditures only because current-year additions

to capital are depreciated. This depreciation of new capital is small in comparison to the total capital assets depreciated by the segment in any year. To show the difference between the depreciation of total and new capital, the mean depreciation rate of the defense industry segments for the first three year average was 4.64% while the ratio of the average value of depreciation to average capital expenditures is 0.57.

Testing the Relationship

The predictive ability of the two baseline models are presented in Table 8. The variables for each model are listed with their elasticity measured at the mean, coefficient, and t-statistic from each averaged year group.

The first model performs well in all three year groups, accounting for a large degree of the variability of capital expenditures. The coefficients are significant to the 0.05 level or better. DEP dominates the model's correlation with capital investment, as shown in Tables 7 and 8. The elasticity measures in Table 8 is used to compare the impact of the different variables because they are expressed in different units. The DEP elasticity measure in Table 8, Eq (12) indicates that a 10% increase in depreciation results in an 8.2%, 6.4%, or 6.6% increase in capital expenditures, depending on the year group.

The impact and significance of the DEP variable caused further concern that depreciation may be misstated in this model. To investigate the possible incorrect treatment of depreciation, the rate of depreciation was substituted in the first proposed model. The regression results of the depreciation rate variable indicated that its estimated coefficient was significant at the same level as depreciation (0.0005). A stepwise

TABLE 8

Regression Results

(Eq12)

NSAL	DEP	COR	$\bar{R}^2$	N
Average Data of 1977-1979				
(.1487)(a)	(.8197)	(.3153)		
.0074(b)	1.5359	17.7224	.9265	130
(3.296)(c)	(25.179)	(4.174)		
Average Data of 1980-1982				
(.3870)	(.6404)	(.2377)		
.0206	1.5329	21.8796	.8898	116
(6.444)	(23.553)	(2.408)		
Average Data of 1983-1984				
(.3709)	(.6654)	(.1854)		
.0207	1.1503	20.2365	.8508	102
(4.053)	(8.222)	(1.708)		

(Eq14)

NSAL	DEP	BLG	GSL	$\bar{R}^2$	N
Average Data of 1977-1979					
(.2207)	(.8316)	(-.0710)	(.0561)		
.0107	1.4505	-.0095	.0140	.9586	76
(4.248)	(26.430)	(3.168)	(2.672)		
Average Data of 1980-1982					
(.4971)	(.5547)	(.0193)	(.0179)		
.0269	1.0490	.0032	.0033	.9454	50
(7.477)	(12.894)	(.766)**	(.689)**		
Average Data of 1983-1984					
(.0618)	(.7599)	(.2147)	(.1011)		
.0033	1.2317	.0126	.0154	.8537	54
(.462)*	(8.008)	(1.687)	(1.846)		

(a) elasticity, (b) estimated coefficient, (c) t-statistic

Parameter significance levels are (one tailed t test) 0.05
except: * = .35, ** = .25
Regression relation significance level is 0.001 (F test)

regression confirmed that depreciation rate would be among the best set of independent variables that account for the variability of capital expenditures. The elasticity measure indicated that a 10% increase in the rate of depreciation would result in an 8.6% increase in capital expenditures. The rate of depreciation variable supported the results of the present model. Depreciation is the single most important predictor of capital investment.

The NSAL elasticity measure shows the smaller impact of sales. A 10% increase in sales would produce an increase in capital investment between 1.5% and 3.8% depending on the year group. This small measure of elasticity is similar to previous work (17:238) where data indicated that in the short term a 10% increase in sales would result in no more than 1 or 2 percent increase in capital stock. The elasticity of the COR variable indicates that a 10% increase in the capital-output ratio would result in a 3.1%, 2.3%, or 1.8% change in capital investment. It is important to realize that the elasticity measures provide a method of making inferences concerning mean responses. The elasticity measure is based on information about the means of the variables and the data contains more information value at the mean.

The elasticity measure for DEP in Eq (12) decreases in the second time period and increases very little in the third period. The Accelerated Cost Recovery Act of 1980 does not appear to have changed the impact of depreciation as much as might have been expected. The expected result of the depreciation regulation change would have been a sharper increase in the impact of depreciation on capital expenditures in the third time period. The depreciation variable accounts for most of

the variability of capital expenditures and indicates that the defense industry relies on liquidity as a determinant of capital expenditures.

The change in the elasticity measure for NSAL suggests an increase in the influence of output on the level of capital expenditures. This change does not follow the economic recovery because the third year group would be more influencial than the second. The change in NSAL elasticity may reflect the change in defense spending that coincides with the Reagan Administration taking office. The net-sales elasticity more than doubles in the second year group and then does not change appreciably in the third year group. The impact of the government sales variable might be even more effective if applied to this data set.

The trend in elasticity for the capital output ratio is a weakening one. This would indicate that capital intensity was becoming less effective as a determinant of investment. It might suggest that sales levels are becoming more important while the level of assets are becoming less influencial to capital expenditures. The correlation of the model decreases over time as well.

The regression results of the second baseline model are presented in Table 8, Eq (14). DEP remains the dominant predictor variable in all three year groups. The continued preeminence of the depreciation variable suggests that the defense industry relies heavily on depreciation as a source of funds for capital expenditures. The elasticity measures of DEP indicate a 10% increase in the level of depreciation corresponds to an 8.3% increase in the level of capital expenditures in the first year group, a 5.5% increase in the second, and a 7.6% increase in the third year group. DEP is the only variable that remains significant at

an acceptable level in all three year groups. The estimated coefficients of the other variables remain close to zero. The significance level of BLG and GSL drop to 0.25 in the second year group and the significance level of NSAL drops to 0.35 in the third. The sign of the BLG variable also changes from negative to positive. The impact of the other variables changes more in this model as indicated by the range of the elasticities.

The elasticity of NSAL indicates a 10% increase in net sales would produce a 2.2%, 4.9%, or 0.6% increase in capital expenditures. The sign of the backlog variable changes along with the sign of the elasticity. This change in the relationship between order backlog and capital expenditures suggests a change in the perceptions within the defense industry. Order backlog has become an indicator of demand and the industry is behaving differently after 1980. The elasticity measure for BLG in the third year group would indicate that a 10% increase in order backlogs corresponds to 2.1% increase in capital expenditures, which is much greater than the 0.7% decrease in the first year group. The elasticity of government sales indicates a 10% increase in GSL would produce a 0.5% increase in capital expenditures in the first year group and a 1.0% increase in the third year group.

The trends in elasticities indicate that government sales are growing in importance relative to net-sales. The government sales variable doubled its elasticity while NSAL lost significance. The elasticity measure of the depreciation variable was smaller in the second year group and recovered in the third. Addressing only the reduced data set, the results of this comparison suggest a growing influence for government sales.

The two models are tested to determine if the set of independent variables continue to maintain a statistically similar relationship to the dependent variable in the three year groups. The test of the regression functions for each model determines if the estimated coefficients in each year group are the same. If the estimated coefficients are the same, the regression relation established for one year group applies to all three year groups. This would confirm the predictive ability of the model.

The comparison of the regression functions for the first model (Table 8, Eq (12)) indicated that the estimated coefficients for the data of the three year groups were the same with a confidence level of 0.95. The F statistic for this test was 1.69 and was sufficiently less than the critical value ($F(.95;8,336) = 1.94$) to conclude that the model was consistent in each time period.

The second model fails the test (Table 8, Eq (14)). This failure indicates that the estimated coefficients for the different year groups are statistically different. The backlog variable (BLG) changed sign and lost significance. The government sales variable (GSL) and the size variable (NSAL) both lost significance. The second baseline model does not provide a reliable set of independent variables over the three data sets. The results of this test also indicate that the first model is a reliable predictor for capital expenditures in the defense industry.

V. Conclusion

Summary

The purpose of this research was to investigate the factors that influence capital investment in the defense industry. To accomplish this task a descriptive model was developed that included a number of candidate variables. From the proposed model a set of variables was selected that best captured the variability of capital expenditures. This process resulted in three different sets of variables. The selected sets of variables were then evaluated to determine their relative contribution to explaining the variability of capital expenditures. This process resulted in two sets of variables. One model was developed using a subset of the total available data. This model allowed the inclusion of the level of government sales as a variable. The other model was based on the entire available data set. The two models were evaluated and only the model that used the entire data set represented a relationship that remained consistent throughout the three time periods. This model represents the best set of variables for capturing the changes in the level of capital expenditures in the defense industry.

Return on sales and return on investment were not significant in describing the variability of capital expenditures. This is a surprising result when so much attention is given to comparing these measures between the commercial sector and the defense industry. The level of depreciation was far more important than profit margins.

The change in capital expenditures was captured better by depreciation than by any other variable. The depreciation variable was responsible

for most of the correlation in the models. The significant impact of depreciation on the change in the level of capital expenditures points to the importance of liquidity in the defense industry. The internal source of funds is essential for capital investment, as indicated here. The trend in the impact of depreciation showed only minor changes. It is noteworthy that the application of the Accelerated Cost Recovery System did not appear to change the influence of depreciation. Allowing depreciation in a shorter time was expected to have a positive impact on the relationship with capital expenditures. The changes in the level of depreciation over time were not addressed but were assumed to increase especially following the implementation of the Accelerated Cost Recovery System.

The influence of sales was significant in describing the changes in the level of capital expenditures. The influence of sales supports the accelerator investment theory where output is the determinant of investment. The ability of the net-sales variable to capture the variability of capital expenditures increased following 1979 and is attributed to the increase in defense spending. Defense spending increased 3 billion dollars in 1980, 4 billion in 1981 and 5 billion in 1982, in constant 1972 dollars. The largest change in defense spending prior to this was a 1 billion dollar increase in 1978 and 1979 and a 1 billion decrease in 1975 and 1976 (46:432).

This conclusion is further supported when the model controls for the level of government sales. The influence of government sales during the latter years studied was more significant and accounted for almost twice as much of the variability of capital expenditures as net-sales.

The influence of the level of government sales also indicates that government action in addition to increased sales may have encouraged capital expenditures. Programs like TechMod are in addition to the weighted guidelines profit policy and may have added to the increased impact of government sales and encouraged capital expenditures.

The capital-output ratio contributed to the model's ability to describe the changes in the level of capital expenditures. The decrease in its relative contribution was caused by less capital intensive segments increasing their capital expenditures. Capital investment became less dependent on the level of capital assets of the segments. This suggests that replacement investment was not as dominant in the later years covered by this study.

Conclusions

The results of this study show the importance of liquidity to capital expenditures in the defense industry. Liquidity includes profit as well as depreciation. The emphasis of profit margins in Defense Department policy is appropriate because the internal source of funds is extremely important for financing capital investments. This says little of the success or failure of the Defense Department's profit policy. The contracting officers and Congressmen who guard the "purse strings" continue to view their job as limiting the profits of the defense industry.

The underlying reason for wanting capital investment by the defense industry is to improve productivity and to lower costs for the government. The need for funds to finance capital expenditures will be satisfied by the government either through increased profits or more generous depreciation allowances. In order to reduce the costs of future procurements the

government must surrender some current funds. Higher profits must be paid or reduced tax revenues must be accepted as a result of increased depreciation, or both.

Recommendations

The recommendations that result from this segment level study of defense industry capital investment are to improve the focus of the DOD profit policy and to evaluate the possibility of creating a special depreciation allowance for the defense industry. Both recommendations relate specifically to increasing the level of capital expenditures within the defense industry.

The weighted guidelines profit policy does not sufficiently emphasize the importance of capital investment. This presumes that we accept the profit policy as a tool for behavior modification. It would appear that the concepts of a free market and the "invisible hand" have limited application to the defense industry when negotiation has replaced competition for determining profit. The weighting factor that rewards capital investment should be increased where productivity and cost reduction can be demonstrated. This means returning the special productivity factor. The method of measurement will have to be clear and simple. The associated profit will have to be a strong incentive to encourage the desired productivity and cost reduction.

The level of depreciation has been shown to be closely correlated with capital expenditures in the defense industry. A change in the depreciation allowance specifically for defense contractors would provide the funds needed for capital investment. A special depreciation allowance would have the advantage of making capital expenditures less

expensive to the defense firms which would encourage investment. Additionally, this method would not involve the onerous requirement of paying higher profits to defense contractors. The depreciation allowance could be graduated in accordance with the level of defense related business to include major prime contractors and sub-contractors.

Appendix A

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SMBL SID CNUM    SIC     SALES    PROFIT   DEPREC      CAPX       ASSET
     BLG       GSL        MKT     COC    COR    ROI      ROS    SIR

FMC0   5.302491.2879.   520.294   41.293   20.300      38.168   416.079
    73.300      .000    140.768  .075  .800  1.082     .079  13.632
FMC1   6.302491.2812.   674.951   94.686   40.588      97.939   600.275
      .000      .000    182.612  .075  .889   .967     .140   6.892
FMC2   7.302491.3535.   641.586   51.036   10.386      23.911   348.386
   616.967      .000    173.584  .075  .543  2.134     .080  26.832
FMC3   8.302491.3536.   456.717   18.001   14.503      30.191   376.353
   113.000      .000    123.567  .075  .824   .596     .039  15.128
FMC4   9.302491.3711.   457.905   53.249    5.421      17.568   140.248
   760.667      .000    123.889  .075  .306  3.031     .116  26.065
FMC5 11.302491.3549.    110.051    4.982    2.026       3.267    58.032
    17.733      .000     29.775  .075  .527  1.525     .045  33.686
HPC0   5.427056.2821.   551.667   35.000   45.000      59.000   557.667
      .000      .000    197.805  .065 1.011   .593     .063   9.350
HPC1   6.427056.2899.   336.333   40.667   14.667      29.667   228.333
      .000      .000    120.595  .065  .679  1.371     .121  11.337
HPC2   7.427056.2821.   446.667   54.667   15.000      30.000   260.000
      .000      .000    160.156  .065  .582  1.822     .122  14.889
HPC3   8.427056.2892.   248.333   15.333   10.000      13.000    93.333
      .000    63.000     89.042  .065  .376  1.179     .062  19.103
HPC4   9.427056.2821.   205.000   32.000    6.000       8.000   102.000
      .000      .000     73.505  .065  .498  4.000     .156  25.625
HPC5 10.427056.2816.    276.667    6.333   14.000       6.000   149.667
      .000      .000     99.201  .065  .541  1.056     .023  46.111
GY 0   1.371352.3011.   963.351   63.605   32.357      36.661   679.912
      .000      .000    204.603  .063  .706  1.735     .066  26.277
GY 1   2.371352.3079.   461.894   45.567    9.842      15.971   226.897
      .000      .000     98.100  .063  .491  2.853     .099  28.921
GY 2   8.371352.3764.   269.031   28.723    5.957      11.683    90.885
      .000   168.127     57.139  .063  .338  2.459     .107  23.028
GY 3   9.371352.3443.   200.924    9.103    2.091       2.417    65.557
      .000      .000     42.674  .063  .326  3.766     .045  83.129
GY 4 10.371352.3561.    142.026   13.985    4.955      12.075   116.526
      .000      .000     30.164  .063  .820  1.158     .098  11.762
GY 5 99.371352.3500.    164.148   12.889    3.103       5.283    61.840
      .000      .000     34.863  .063  .377  2.440     .079  31.071
GY 6   4.371352.4832.   124.321   24.959    2.576       5.251    91.815
      .000      .000     26.404  .063  .739  4.753     .201  23.676
GY 7   5.371352.2086.    78.951   11.361    2.555       5.352    44.090
      .000      .000     16.768  .063  .558  2.123     .144  14.752
GY 8   6.371352.4833.    32.847    6.603    3.523      10.506    55.117
      .000      .000      6.976  .063 1.678   .628     .201   3.126
GT 1   2.382550.3041.   864.567   65.367   25.100      33.700   471.567
      .001      .000    127.302  .082  .545  1.940     .076  25.655
GT 2 99.382550.3728.    336.167   50.433    6.900      11.267   180.767
   331.993      .000     49.498  .082  .538  4.476     .150  29.836
CDA0   1.212363.3573.  1884.567  134.860  133.211     193.363  2021.482
   301.333   248.272    655.114  .077 1.073   .697     .072   9.746
IBM2   4.459200.7392.    61.667    6.000    1.000       1.000    37.000
      .000      .000    329.949  .101  .600  6.000     .097  61.667
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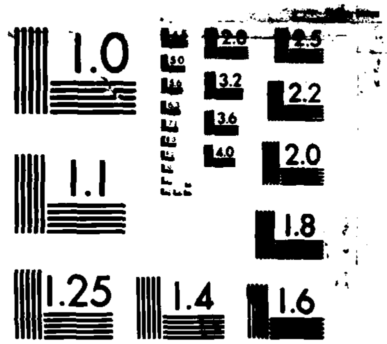
SMBL	SID CNUM	SIC	SALES	PROFIT		DEPREC	CAPX	ASSET
	BLG	GSL	MKT	COC	COR	ROI	ROS	SIR
HON0	2.438506.3573.		726.000	106.800		15.067	31.633	507.933
	.000	23.967	386.421	.094	.700	3.376	.147	22.951
HON1	3.438506.3662.		676.133	42.400		10.600	22.533	235.333
	.000	399.100	359.878	.094	.348	1.882	.063	30.006
HON2	4.438506.3573.		1261.067	112.367		192.867	298.333	1081.267
	.000	132.033	671.215	.094	.857	.377	.089	4.227
EMR0	1.291011.3621.		1427.000	213.500		37.500	65.000	876.000
	.000	.000	1206.451	.091	.614	3.285	.150	21.954
EMR1	2.291011.3623.		781.000	132.000		15.500	29.500	484.500
	.000	.000	660.293	.091	.620	4.475	.169	26.475
EMR2	3.291011.3662.		187.500	22.500		2.000	4.000	70.500
	.000	.000	158.521	.091	.376	5.625	.120	46.875
WX 0	1.960402.3612.		2346.279	138.767		62.333	120.667	2033.537
	7.300	158.077	550.256	.081	.867	1.150	.059	19.444
WX 1	3.960402.3621.		2545.546	213.030		36.667	71.667	1283.120
	657.667	33.613	596.989	.081	.504	2.972	.084	35.519
WX 2	4.960402.3662.		1576.490	86.218		22.000	42.000	770.070
	1833.333	575.053	369.723	.081	.488	2.053	.055	37.535
WX 3	5.960402.4832.		199.074	56.681		5.333	14.333	117.715
	.000	.000	46.687	.081	.591	3.955	.285	13.889
GLD0	2.383492.3690.		396.167	49.833		9.767	21.533	237.100
	.000	.000	151.451	.098	.598	2.314	.126	18.398
GLD1	4.383492.3613.		552.967	47.033		11.900	18.100	353.533
	.000	.000	211.394	.098	.639	2.599	.085	30.551
GLD2	5.383492.3825.		398.200	70.833		8.433	22.567	278.333
	.000	.000	152.228	.098	.699	3.139	.178	17.645
GLD3	6.383492.3362.		453.633	77.367		10.033	22.967	342.300
	.000	.000	173.419	.098	.755	3.369	.171	19.752
SMF0	1.829302.3636.		1156.100	75.300		26.467	27.900	632.800
	.000	385.540	110.454	.068	.547	2.699	.065	41.437
SMF1	2.829302.3636.		133.833	-5.167		1.933	1.267	118.733
	.000	.000	12.786	.068	.887	-4.078	-.039	105.630
SMF2	3.829302.3630.		166.600	25.033		1.900	5.333	62.467
	.000	.000	15.917	.068	.375	4.694	.150	31.239
SMF3	4.829302.2510.		148.833	20.967		3.700	3.200	67.867
	.000	.000	14.220	.068	.456	6.552	.141	46.510
SMF4	5.829302.3662.		125.800	11.833		4.233	5.267	47.767
	.000	.000	12.019	.068	.380	2.247	.094	23.885
SMF5	6.829302.3585.		119.533	2.733		1.400	2.000	49.333
	.000	.000	11.420	.068	.413	1.367	.023	59.767
SMF6	7.829302.3824.		75.900	9.967		1.167	1.533	33.767
	.000	.000	7.252	.068	.445	6.502	.131	49.511
SMF7	8.829302.3728.		453.667	28.100		8.333	11.100	200.633
	525.000	.000	43.344	.068	.442	2.532	.062	40.871
SMF8	9.829302.3861.		70.433	5.233		1.600	.733	20.133
	.000	.000	6.729	.068	.286	7.139	.074	96.089
RCA0	1.749285.3651.		1574.033	140.067		32.600	48.000	786.667
	.000	.000	440.353	.059	.500	2.918	.089	32.792
RCA1	2.749285.3670.		979.300	85.233		28.000	36.167	502.000
	.000	.000	273.970	.059	.513	2.357	.087	27.077

AD-A167 603 A SEGMENT LEVEL STUDY OF DEFENSE INDUSTRY CAPITAL INVESTMENT(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF ENGINEERING R H SEARLE DEC 85 2/2

UNCLASSIFIED AFIT/GSO/ENS/85D-14 F/G 5/3 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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SMBL SID CNUM    SIC     SALES     PROFIT   DEPREC      CAPX      ASSET
     BLG       GSL        MKT      COC    COR    ROI     ROS    SIR

RCA2  3.749285.4832. 1225.933  126.767   15.200      28.333   613.000
       .000      .000  342.968  .059  .500  4.474     .103  43.269
RCA5  6.749285.9100.  540.700   26.533    8.467      12.000   116.667
   511.000  540.700   151.267  .059  .216  2.211     .049  45.058
RCA6 99.749285.2000. 1062.233   68.267   17.400      37.733   485.333
       .000      .000  297.171  .059  .457  1.809     .064  28.151
ESY0  2.269157.4582.   51.968    4.728     .480        .849    19.245
    39.602  176.443    18.734  .084  .370  5.569     .091  61.211
ESY1  3.269157.3662.  160.662   14.550    2.522       3.876    53.354
   175.541  205.183    57.916  .084  .332  3.754     .091  41.450
ESY2  6.269157.3662.   28.710    3.615     .502       1.112    22.182
    50.495  168.887    10.349  .084  .773  3.251     .126  25.818
ESY3  7.269157.3662.  113.594   10.595    1.835       3.279    57.940
   117.937  183.603    40.949  .084  .510  3.231     .093  34.643
HRS0  2.413875.3662.  203.650   21.850    3.322       8.303    75.540
   145.000      .000  170.060  .071  .371  2.632     .107  24.527
HRS1  3.413875.3555.  260.200   39.450    3.035      14.597   189.093
   230.000      .000  217.283  .071  .727  2.703     .152  17.826
HRS2  4.413875.3573.  172.350   18.250   16.555      40.544   173.762
   130.000      .000  143.923  .071 1.008   .450     .106   4.251
HRS3  5.413875.3662.  209.250   26.650    3.135      11.994   131.885
    97.500      .000  174.737  .071  .630  2.222     .127  17.446
HRS4  6.413875.3674.   81.700   15.100    5.420      13.636    70.784
    47.500      .000   68.225  .071  .866  1.107     .185   5.991
MOT0  1.620076.3662.  968.709  130.119   29.460      52.729   673.254
   216.955      .000  669.454  .092  .695  2.468     .134  18.371
MOT1  2.620076.3674.  727.019  119.778   39.749      94.650   502.822
   326.700      .000  502.427  .092  .692  1.265     .165   7.681
MOT2  3.620076.3694.  200.542    1.470    9.152      11.299   145.383
       .001      .000  138.590  .092  .725   .130     .007  17.749
RTN0  1.755111.3662. 1844.167  215.000   59.333     136.333  1490.667
       .000 1213.667  865.673  .110  .808  1.577     .117  13.527
RTN1  2.755111.1542.  759.267   34.333   17.333      20.000   223.333
   795.333      .001  356.409  .110  .294  1.717     .045  37.963
RTN2  3.755111.3631.  420.767   21.000    5.667      11.667   234.667
       .000      .001  197.513  .110  .558  1.800     .050  36.065
RTN3 99.755111.3531.  237.433   21.667    5.667       9.333   108.333
       .000      .001  111.454  .110  .456  2.322     .091  25.440
SAA0  4.799850.3662.  151.901   22.509    3.435       5.520   120.025
   151.000  112.937   128.649  .088  .790  4.078     .148  27.518
ROK0  1.774347.3714. 1661.500  185.450   35.050      76.350   851.500
   635.000      .000  365.045  .080  .512  2.429     .112  21.762
ROK1  2.774347.3662. 1396.500  126.050   36.900      80.200   843.500
  1257.500      .650  306.823  .080  .604  1.572     .090  17.413
ROK2  6.774347.3764. 1539.000   96.150   16.350      21.200   420.000
   740.000     1.300  338.131  .080  .273  4.535     .062  72.594
ROK3  7.774347.3546. 1325.500   98.050   24.600      54.250   803.500
   657.500      .000  291.223  .080  .606  1.807     .074  24.433
TRW0  1.872649.3674. 1248.667   81.967   33.733      47.700   600.867
   889.367  606.000   330.272  .073  .481  1.718     .066  26.178
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SMBL SID CNUM    SIC     SALES     PROFIT   DEPREC      CAPX       ASSET
     BLG      GSL        MKT      COC    COR    ROI      ROS    SIR

TRW1  2.872649.3714. 1532.667   201.400    39.833      71.567   940.567
       .000     7.100   405.389  .073  .614  2.814     .131  21.416
TRW2  4.872649.3562. 1089.000   120.900    26.000      35.333   660.733
    600.953  144.733   288.040  .073  .607  3.422     .111  30.821
FEN0  6.303711.3761.    31.515    2.116      .506        .779    10.520
     18.275     .000     8.616  .120  .334  2.716     .067  40.456
FEN3 11.303711.3721.   364.959   40.756     3.539       8.591   114.749
    495.327     .000    99.780  .120  .314  4.744     .112  42.482
FEN4 12.303711.3721.   132.550   20.406      .726       2.243    77.462
    182.035     .000    36.239  .120  .584  9.098     .154  59.095
LK 0  2.539821.3761. 1529.500   84.000    18.500      24.000   283.500
   1795.500     .000   120.924  .058  .185  3.500     .055  63.729
LK 1 99.539821.3731.   131.500    8.000     1.500       1.500    36.000
    136.000     .000    10.396  .058  .274  5.333     .061  87.667
LK 2  4.539821.3721.   564.500   66.000     4.500      31.000   238.500
    411.500     .000    44.630  .058  .422  2.129     .117  18.210
LK 3  5.539821.3721. 1136.000     .127    13.500      38.500   449.500
   1303.500     .000    89.813  .058  .396   .003     .000  29.506
NOC0  1.666807.3721.   743.419   95.730    10.502      47.002   374.998
    492.667  452.771   206.599  .130  .504  2.037     .129  15.817
NOC1  2.666807.3662.   214.832   13.959     5.200       7.632   101.104
    225.267  282.940    59.703  .130  .471  1.829     .065  28.149
NOC4 99.666807.3811.    40.929    3.536     1.424       1.937    23.410
       .000  214.362    11.374  .130  .572  1.826     .086  21.130
BA 1  3.197023.3761.   568.267   27.067     8.567      21.467   120.833
    299.000  568.300   250.223  .095  .213  1.261     .048  26.472
GD 3 14.369550.1499.   138.246   23.503    11.573      19.850   237.217
       .605     .000    40.171  .114 1.716  1.184     .170   6.965
GD 4 16.369550.3661.   206.333    -.333     4.000       5.667   141.000
       .000    9.333    59.955  .114  .683  -.059    -.002  36.410
GD 5 17.369550.3273.   649.333   64.667    25.000      47.333   358.667
       .000  111.667   188.680  .114  .552  1.366     .100  13.718
GQ 0  5.400181.3721. 1192.267   83.573    13.988      14.879   366.371
   1968.000 1144.284   116.975  .100  .307  5.617     .070  80.131
GQ 1  6.400181.3711.   176.463  -14.998     3.487       5.579   151.826
    188.000     .001    17.313  .100  .860 -2.688    -.085  31.630
GQ 3  8.400181.3731.   139.568    3.256     3.511       6.696   219.183
     48.500     .001    13.693  .100 1.570   .486     .023  20.843
MD 2  7.580169.3761.   701.800   53.522     7.391      20.976   408.044
    462.667     .000   194.129  .054  .581  2.552     .076  33.457
MD 3  8.580169.7374.   175.933    5.260    17.538      60.749   214.338
     33.000     .000    48.666  .054 1.218   .087     .030   2.896
UTX1  2.913017.3721.   736.684   41.205    15.163      40.908   428.474
   1389.333  413.128   158.176  .095  .582  1.007     .056  18.008
UTX2  4.913017.3585. 3167.942  260.777    50.980      69.431  2125.061
   1989.333     .000   680.200  .095  .671  3.756     .082  45.627
TOD0  5.889039.3731.   322.677    5.499     3.812       4.399   137.328
   1200.000  221.500    38.914  .077  .426  1.250     .017  73.352
ML 0  1.573275.3241.   177.767   27.367    11.533      12.067   165.867
       .000     .000    81.016  .061  .933  2.268     .154  14.732
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SMBL	SID CNUM SIC / BLG	GSL	SALES / MKT	PROFIT / COC	COR	DEPREC / ROI	CAPX / ROS	ASSET / SIR
ML 1	2.573275.1429.		155.100	36.433		17.267	34.967	145.467
	.000	.000	70.686	.061	.938	1.042	.235	4.436
ML 2	3.573275.2899.		209.133	50.467		9.133	15.033	149.267
	.000	.000	95.311	.061	.714	3.357	.241	13.912
ML 3	4.573275.3334.		544.800	70.350		16.250	51.100	533.950
	.000	18.500	248.289	.061	.980	1.377	.129	10.661
ML 4	5.573275.3764.		732.067	60.333		14.733	30.600	222.933
	.000	667.667	333.634	.061	.305	1.972	.082	23.924
ITT2	11.460470.2222.		666.500	39.000		10.500	15.500	340.000
	.000	.000	127.417	.094	.510	2.516	.059	43.000
ITT3	12.460470.3333.		1626.000	159.000		31.500	81.000	967.000
	.000	.000	310.848	.094	.595	1.963	.098	20.074
ITT4	13.460470.4444.		2741.000	194.000		42.500	81.500	1722.000
	.000	.000	524.007	.094	.628	2.380	.071	33.632
ITT5	14.460470.5555.		1035.000	93.500		32.500	74.000	740.000
	.000	.000	197.865	.094	.715	1.264	.090	13.986
ITT6	15.460470.6666.		1722.500	51.500		37.500	59.000	501.500
	.000	.000	329.297	.094	.291	.873	.030	29.195
ITT7	16.460470.7777.		900.000	12.000		21.500	37.000	585.500
	.000	.000	172.056	.094	.651	.324	.013	24.324
ITT8	17.460470.8888.		1042.500	90.500		29.000	92.000	915.000
	.000	.000	199.299	.094	.878	.984	.087	11.332
ITT9	18.460470. 0.		1185.500	121.500		85.000	208.500	1796.500
	.000	.000	226.636	.094	1.515	.583	.102	5.686
LTV1	3.502210.2222.		523.005	49.475		6.819	9.227	205.629
	955.256	.000	11.668	.045	.393	5.362	.095	56.682
LTV2	8.502210.3333.		3143.799	109.715		89.335	198.147	2678.586
	.000	404.061	70.136	.045	.852	.554	.035	15.866
LTV3	9.502210.4444.		528.287	43.710		1.409	4.518	296.817
	.000	.000	11.786	.045	.562	9.675	.083	116.929
LTV4	10.502210.5555.		334.099	19.780		5.122	20.053	243.443
	.000	.000	7.454	.045	.729	.986	.059	16.661
TDY0	1.879335.1111.		925.485	149.247		30.683	55.487	321.807
	.000	.000	443.938	.049	.348	2.690	.161	16.679
TDY1	2.879335.2222.		590.859	77.996		10.649	15.601	148.745
	.000	.000	283.424	.049	.252	4.999	.132	37.873
TDY2	3.879335.3333.		769.637	125.454		16.168	19.713	242.419
	.000	.000	369.181	.049	.315	6.364	.163	39.042
TXT0	2.883203.2222.		1034.400	96.250		19.250	36.550	618.500
	.000	.000	256.990	.024	.598	2.633	.093	28.301
TXT1	3.883203.3333.		618.750	52.300		15.050	22.200	286.100
	.000	.000	153.724	.024	.462	2.356	.085	27.872
TXT2	4.883203.4444.		650.300	89.900		11.800	22.300	387.200
	285.500	.000	161.563	.024	.595	4.031	.138	29.161
TXT3	5.883203.5555.		830.500	81.000		9.000	12.000	380.500
	.000	.000	206.332	.024	.458	6.750	.098	69.208
TXT4	6.883203.6666.		178.000	16.000		3.500	5.000	86.000
	.000	.000	44.223	.024	.483	3.200	.090	35.600
LIT0	5.538021.5555.		1020.130	42.946		20.921	32.863	485.214
	86.289	.000	238.177	.048	.476	1.307	.042	31.042

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SMBL SID CNUM    SIC     SALES     PROFIT   DEPREC      CAPX       ASSET
     BLG        GSL       MKT      COC    COR    ROI      ROS    SIR

LIT1  6.538021.6666.  696.376  112.642   30.937      55.903   408.739
   359.692      .000  162.588  .048  .587  2.015   .162  12.457
LIT2  7.538021.7777.  750.203   66.261   10.652      22.909   373.931
   277.946      .000  175.155  .048  .498  2.892   .088  32.747
LIT3  8.538021.8888.  312.301   22.137   10.540      15.260   197.473
    33.262      .000   72.915  .048  .632  1.451   .071  20.465
LIT4  9.538021.9999.  494.927   53.985    8.449      17.139   214.066
  1411.675      .000  115.554  .048  .433  3.150   .109  28.877
LIT5 10.538021.1111.  581.716   27.085   15.250       8.534   251.236
  1249.902      .000  135.817  .048  .432  3.174   .047  68.165
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Appendix B

SMBL	SID	SIC	SALES	DEPREC	CAPX	ASSET	BLG	GSL	COR
BA	3.	3761.	704.500	17.800	36.233	204.633	761.000	704.500	.290
CDA	1.	3682.	2933.450	186.400	283.500	2680.350	.000	330.900	.914
EMR	1.	3621.	1933.333	56.667	85.000	1214.333	.000	.000	.628
EMR	2.	3646.	1101.333	25.000	32.333	670.667	.000	.000	.609
EMR	3.	3662.	298.000	5.000	10.667	113.667	.000	298.000	.381
ESY	8.	3579.	17.584	.413	.309	16.596	25.705	.000	.944
ESY	3.	3662.	300.167	3.251	12.957	77.712	396.414	.000	.259
ESY	6.	3662.	47.138	1.188	2.404	53.619	85.640	.000	1.137
ESY	7.	3662.	144.126	2.657	4.649	82.306	373.782	.000	.571
FEN	14.	3721.	236.868	2.187	4.900	233.593	299.632	.000	.986
FEN	18.	3721.	542.315	7.243	6.675	107.870	489.288	.000	.199
FEN	17.	5072.	115.677	3.207	6.578	128.368	39.839	.000	1.110
FMC	6.	2812.	895.377	60.733	105.133	794.737	.000	.000	.888
FMC	14.	2879.	436.295	19.900	22.400	294.031	.000	.000	.674
FMC	15.	3523.	960.993	27.950	38.250	631.779	432.550	.000	.657
FMC	12.	3533.	339.302	11.850	36.950	275.341	151.150	.000	.811
FMC	13.	3795.	800.202	16.350	48.550	301.436	2128.900	.000	.377
GD	13.	3731.	120.067	8.900	.233	70.533	324.767	.000	.587
GE	20.	3641.	3866.000	124.000	180.000	1997.000	.000	.000	.517
GE	18.	3670.	3415.000	90.000	247.000	2011.000	.000	.000	.589
GE	19.	3724.	2870.333	76.333	188.667	1942.667	.000	.000	.677
GLD	4.	3613.	532.750	10.550	15.000	287.100	.000	.000	.539
GLD	2.	3691.	433.350	13.750	28.900	288.150	.000	.000	.665
GLD	5.	3825.	768.050	15.250	53.600	519.250	.000	.000	.676
GQ	6.	3711.	207.037	3.589	3.620	214.430	126.667	.000	1.036
GT	2.	3041.	1015.233	25.600	21.200	499.467	.000	.000	.492
GT	99.	3728.	518.300	8.433	32.433	229.333	671.378	.000	.442
GTE	3.	3641.	1783.000	39.667	86.333	1320.667	.000	.000	.741
GTE	4.	3661.	2278.333	43.667	98.333	1762.667	.000	.000	.774
GY	1.	3011.	1033.407	38.192	39.055	688.053	.000	.000	.666
GY	11.	3069.	137.722	3.951	3.349	58.802	.000	.000	.427
GY	2.	3079.	405.685	11.636	11.976	210.523	.000	.000	.519
GY	8.	3764.	457.361	11.902	30.225	180.386	583.333	437.000	.394
HON	3.	3662.	1119.367	22.033	54.300	506.533	.000	693.367	.453
HON	6.	3822.	937.667	32.267	83.233	694.367	.000	7.300	.741
HON	7.	3823.	1500.900	32.833	64.367	881.800	.000	47.167	.588
HPC	10.	2816.	325.667	8.667	8.000	167.677	.000	.000	.515
HPC	5.	2821.	713.667	53.000	71.333	656.333	.000	.000	.920
HPC	7.	2821.	573.333	19.667	32.333	291.000	.000	.000	.508
HPC	8.	2892.	421.333	12.667	27.000	141.000	.000	299.667	.335
HPC	6.	2899.	523.333	23.667	48.333	368.667	.000	.000	.704
HRS	3.	3555.	407.000	7.700	29.955	325.718	241.333	.000	.800
HRS	2.	3662.	323.233	5.975	17.512	132.252	193.667	.000	.409
HRS	5.	3662.	207.050	4.758	5.224	164.043	147.500	.000	.792
HRS	7.	3662.	130.800	3.251	7.337	92.532	60.000	.000	.707
HRS	6.	3674.	158.567	14.470	45.425	168.463	90.000	.000	1.062
HRS	4.	3681.	237.050	26.054	45.250	234.332	252.500	.000	.989
IBM	3.	3680.	683.000	.500	32.000	403.500	.000	.000	.591
ITT	15.	2051.	1671.000	37.000	66.333	456.333	.000	.000	.273
ITT	18.	2611.	1377.000	95.000	252.000	1662.000	.000	.000	1.207

SMBL	SID	SIC	SALES	DEPREC	CAPX	ASSET	BLG	GSL	COR
ITT	21.	3561.	1065.500	21.000	36.000	575.000	.000	.000	.540
ITT	11.	3662.	853.333	12.333	24.000	342.667	.000	.000	.402
ITT	12.	3741.	1653.667	45.333	74.000	1037.000	.000	.000	.627
LIT	6.	3541.	1164.756	55.601	126.523	698.170	465.962	.000	.599
LIT	11.	3570.	945.185	21.516	36.019	499.105	65.000	.000	.528
LIT	7.	3679.	929.778	16.378	33.565	494.646	351.789	.000	.532
LIT	10.	3731.	716.517	16.469	12.402	154.316	1445.427	.000	.215
LIT	9.	3662.	860.247	16.236	51.333	348.211	2385.418	.000	.405
LK	99.	3731.	193.000	1.667	4.667	47.667	103.000	185.667	.247
LK	5.	3721.	1918.333	27.667	67.000	772.333	1670.000	1268.000	.403
LTV	9.	3312.	1499.378	6.518	24.958	633.701	.000	.000	.423
LTV	3.	3721.	741.953	7.519	20.867	334.127	1474.667	509.541	.450
LTV	8.	3312.	3763.084	100.077	223.593	2750.000	.000	.000	.731
MD	5.	3721.	2333.350	26.750	50.000	2318.050	2334.500	.000	.993
MD	7.	3761.	1026.967	15.933	30.000	730.433	772.067	.000	.711
ML	3.	2899.	252.267	13.100	31.967	214.367	.000	.000	.850
ML	5.	3764.	1823.467	24.800	84.433	387.400	.000	1985.000	.212
NOC	2.	3662.	434.333	9.733	44.733	187.200	557.600	374.466	.431
MOT	1.	3662.	1389.723	41.982	92.002	855.120	284.600	.000	.615
MOT	2.	3674.	1210.580	85.296	173.691	915.183	501.700	.000	.756
RCA	1.	3561.	2111.700	34.233	67.933	1028.767	.000	.000	.487
RCA	6.	3662.	903.833	11.767	23.033	213.400	963.667	903.833	.236
RCA	2.	3671.	1227.067	32.833	57.700	577.200	.000	.000	.470
ROK	10.	3555.	813.000	17.167	27.567	459.000	371.667	.000	.565
ROK	2.	3662.	1839.333	60.000	88.633	1165.333	1686.667	914.333	.634
ROK	1.	3714.	1543.667	46.733	106.867	909.667	406.667	.000	.589
ROK	6.	3760.	2376.667	22.300	92.267	710.333	1080.000	1957.000	.299
ROK	9.	3824.	541.333	11.533	29.333	288.333	205.000	.000	.533
RTN	99.	3531.	305.333	9.000	15.333	145.333	.000	.000	.476
RTN	3.	3632.	615.333	15.667	18.333	364.000	.000	.000	.592
RTN	1.	3662.	2676.667	110.000	186.333	1814.000	.000	1655.333	.678
RTN	4.	3721.	741.667	7.333	25.000	555.000	1236.667	.000	.748
SAA	5.	3662.	200.657	4.424	12.216	100.567	213.633	197.162	.501
SAA	6.	3686.	159.931	3.236	10.131	147.859	87.567	224.073	.925
SMF	3.	3546.	172.533	2.633	3.033	66.333	.000	.000	.384
SMF	6.	3585.	128.650	1.500	1.550	43.400	.000	.000	.337
SMF	5.	3622.	107.000	3.967	3.700	42.267	.000	.000	.395
SMF	10.	3632.	179.667	.533	2.033	127.433	.000	.000	.709
SMF	2.	3636.	142.250	1.900	4.900	111.800	.000	.000	.786
SMF	11.	3636.	1002.300	21.800	29.500	570.050	.000	.000	.569
SMF	8.	3662.	778.733	13.633	32.600	332.367	958.667	.000	.427
SMF	7.	3824.	104.633	1.633	3.200	42.900	.000	.000	.410
TDY	3.	3339.	802.659	21.306	29.988	269.343	.000	.000	.336
TDY	1.	3519.	1093.111	42.490	48.133	335.344	.000	.000	.307
TDY	4.	3634.	283.416	2.695	2.658	71.097	.000	.000	.251
TDY	2.	3720.	830.087	17.547	29.694	199.972	.000	.000	.241
TOD	5.	3731.	704.860	5.915	55.424	322.664	1200.000	601.600	.458
TRW	4.	3452.	1462.667	34.033	60.033	879.300	858.667	250.500	.601
TRW	1.	3662.	2012.000	55.500	102.000	918.033	1497.333	1157.600	.456
TRW	2.	3714.	1659.000	56.567	84.100	1085.167	.000	6.567	.654

SMBL	SID	SIC	SALES	DEPREC	CAPX	ASSET	BLG	GSL	COR
TXN	4.	3471.	140.000	9.333	10.667	89.667	.000	.000	.640
TXN	3.	3662.	891.000	45.667	65.000	316.667	.000	582.947	.355
TXN	1.	3674.	1525.333	159.667	198.333	1000.667	.000	.000	.656
TXN	2.	3681.	1063.000	44.667	55.000	633.333	.000	.000	.596
TXT	13.	3321.	311.500	9.500	7.000	129.000	42.500	.000	.414
TXT	9.	3524.	383.500	8.500	9.500	195.000	.000	.000	.508
TXT	11.	3541.	486.000	12.500	25.500	324.000	189.000	.000	.667
TXT	12.	3546.	388.500	8.500	11.000	193.000	44.000	.000	.497
TXT	5.	3721.	833.333	12.000	17.333	587.000	.000	.000	.704
TXT	8.	3764.	312.500	5.500	11.500	138.500	.000	.000	.443
TXT	10.	3910.	447.000	6.000	7.000	245.500	.000	.000	.549
UTX	7.	3585.	3712.728	55.237	92.841	1706.528	1980.500	.000	.460
UTX	8.	3714.	2556.252	80.377	166.017	1994.474	450.000	.000	.780
UTX	6.	3721.	1826.762	34.912	59.512	888.376	2027.500	.000	.486
WX	3.	3621.	3390.033	50.333	159.667	1685.900	757.333	47.326	.497
WX	4.	3662.	2476.500	31.333	128.000	1150.500	2700.000	1167.600	.465

Appendix C

SMBL	SID	SIC	SALES	DEPREC	CAPX	ASSET	BLG	GSL	COR
BA	3.	3761.	1206.500	23.500	27.000	217.500	1128.000	1206.500	.180
CDA	2.	3680.	3631.700	197.200	221.750	2464.350	.000	430.500	.679
EMR	1.	3621.	2254.500	74.500	104.000	1675.000	.000	.000	.743
EMR	2.	3646.	1121.000	25.000	32.500	685.500	.000	.000	.612
EMR	3.	3662.	452.000	7.500	8.500	164.500	.000	452.000	.364
ESY	3.	3662.	441.267	6.509	19.476	134.660	613.085	.000	.305
ESY	6.	3662.	54.540	1.718	2.916	57.681	85.337	.000	1.058
ESY	7.	3662.	223.222	3.864	8.326	102.182	320.815	.000	.458
FEN	15.	3452.	96.256	4.652	2.427	109.420	55.066	.000	1.137
FEN	16.	3559.	94.976	4.998	3.367	94.953	11.133	.000	1.000
FEN	18.	3721.	288.376	5.775	5.121	61.527	351.607	.000	.213
FMC	6.	2812.	793.800	59.850	47.700	707.850	.000	.000	.892
FMC	14.	2879.	471.900	21.850	26.450	316.500	.000	.000	.671
FMC	15.	3523.	619.100	22.050	20.000	390.300	227.150	.000	.630
FMC	12.	3533.	182.850	14.200	12.850	220.850	50.150	.000	1.208
FMC	13.	3795.	1367.300	25.600	49.450	320.050	2065.200	1193.250	.234
GD	19.	3270.	827.200	58.050	85.000	659.900	.000	135.850	.798
GD	13.	3731.	241.350	4.850	4.200	43.950	587.600	.000	.182
GD	18.	3795.	1202.150	35.850	7.250	533.600	1150.300	1184.600	.444
GE	21.	3632.	3364.000	71.500	95.500	1200.000	.000	.000	.357
GE	20.	3641.	3691.000	131.500	259.000	2339.500	.000	.000	.634
GE	22.	3674.	3907.500	154.500	246.000	2619.500	.000	.000	.670
GE	19.	3724.	3583.000	132.500	287.000	2920.000	.000	.000	.815
GLD	11.	3483.	371.300	6.850	14.100	186.750	.000	.000	.503
GLD	12.	3674.	386.850	20.850	61.650	339.700	.000	.000	.878
GLD	9.	3681.	428.200	21.850	25.600	341.950	.000	.000	.799
GLD	10.	3825.	171.700	8.200	9.900	162.100	.000	.000	.944
GQ	11.	3713.	168.320	2.458	5.480	211.557	65.500	.000	1.257
GT	2.	3041.	1056.000	22.000	32.800	465.300	.000	.000	.441
GT	99.	3728.	746.300	14.650	26.500	285.500	924.650	.000	.383
GTE	3.	3641.	1666.500	46.000	98.500	1191.000	.000	.000	.715
GTE	4.	3661.	2523.000	59.000	114.000	1833.000	.000	.000	.727
GY	1.	3011.	1063.622	37.964	29.488	29.488	667.764	.000	.028
GY	11.	3069.	184.830	3.967	2.915	64.132	.000	.000	.347
GY	2.	3079.	426.483	10.563	9.337	201.106	.000	.000	.472
GY	8.	3764.	544.748	23.090	51.296	303.506	1080.000	507.707	.557
HON	3.	3662.	1574.050	40.000	77.750	751.150	.000	1017.900	.477
HON	4.	3680.	1745.700	166.350	227.300	1316.500	.000	261.850	.754
HON	6.	3822.	1000.300	43.650	70.550	732.050	.000	8.800	.732
HON	7.	3823.	1593.300	45.800	62.100	1023.500	.000	65.000	.642
HPC	10.	2816.	281.000	8.000	14.000	179.000	.000	.000	.637
HPC	5.	2821.	510.500	37.500	18.500	298.500	.000	.000	.585
HPC	7.	2821.	587.500	21.500	35.000	330.500	.000	.000	.563
HPC	8.	2892.	705.000	22.500	44.000	322.500	.000	428.000	.457
HPC	6.	2899.	516.000	27.500	81.500	461.500	.000	.000	.894
HRS	2.	3662.	579.500	13.725	40.003	226.032	375.500	.000	.390
HRS	9.	3662.	413.050	10.713	14.916	331.236	223.500	.000	.802
HRS	8.	3681.	319.500	36.231	49.386	306.071	239.500	.000	.958
ITT	25.	3661.	4411.000	118.000	193.000	3617.000	.000	.000	.820
LIT	9.	3662.	1441.500	39.350	83.750	759.500	2520.000	746.315	.527

SMBL	SID	SIC	SALES	DEPREC	CAPX	ASSET	BLG	GSL	COR
LIT	7.	3679.	988.700	24.750	31.800	475.000	403.500	191.142	.480
LK	7.	3731.	442.000	6.500	12.500	122.000	300.000	350.000	.276
LK	2.	3761.	3390.500	63.000	178.500	1316.000	2750.000	3255.500	.388
LTV	8.	3312.	3728.400	128.350	185.650	4200.998	.000	.000	1.127
LTV	9.	3312.	573.850	9.700	7.350	616.200	.000	.000	1.074
MD	7.	3761.	1378.900	35.250	121.750	1246.750	1470.100	.000	.904
MOT	1.	3662.	1837.500	62.500	144.500	1239.000	507.000	.000	.674
MOT	2.	3674.	1914.000	133.000	293.000	1319.000	1096.500	.000	.689
MOT	5.	3682.	566.000	24.000	53.500	531.000	381.500	.000	.938
NOC	2.	3662.	685.800	21.350	54.450	317.250	956.950	647.100	.463
NOC	1.	3721.	2341.900	90.500	216.900	1154.200	2322.550	1749.500	.493
RCA	99.	2038.	306.400	6.800	7.050	132.150	.000	.000	.431
RCA	7.	3651.	1995.050	38.300	55.950	853.150	.000	.000	.428
RCA	8.	3652.	610.550	5.500	6.900	322.050	.000	.000	.527
RCA	6.	3662.	1370.700	15.150	59.850	363.050	1386.000	1370.700	.265
RCA	2.	3671.	1225.850	32.400	71.950	564.200	.000	.000	.460
ROK	2.	3662.	2291.500	88.350	167.300	1339.500	2230.000	1321.000	.585
ROK	1.	3714.	1481.000	53.900	69.200	950.000	455.000	.000	.641
ROK	6.	3760.	3946.500	66.700	194.100	1174.000	2830.000	3900.000	.297
RTN	99.	3531.	377.500	12.000	15.500	177.500	101.000	.000	.470
RTN	3.	3632.	753.500	17.000	29.000	423.000	24.000	.000	.561
RTN	4.	3721.	682.500	22.000	135.500	850.000	862.000	.000	1.245
SAA	7.	3662.	442.565	12.202	41.798	218.375	454.700	.000	.493
SAA	8.	3686.	227.362	5.348	23.317	182.773	140.550	.000	.804
SMF	4.	2511.	142.450	3.700	3.000	68.300	.000	.000	.479
SMF	3.	3546.	208.700	4.050	4.700	71.500	.000	.000	.343
SMF	1.	3622.	133.700	3.350	5.850	44.000	.000	.000	.329
SMF	12.	3636.	151.350	1.850	2.600	63.850	.000	.000	.422
SMF	8.	3662.	1060.650	24.600	90.750	524.500	1100.000	.000	.495
SMF	7.	3824.	80.700	2.100	1.650	38.600	.000	.000	.478
TDY	3.	3339.	668.250	27.750	19.800	249.350	.000	.000	.373
TDY	1.	3519.	1026.850	40.200	17.550	324.300	.000	.000	.316
TDY	4.	3634.	280.800	2.600	3.000	69.850	.000	.000	.249
TDY	2.	3720.	1260.750	27.200	34.050	267.900	.000	.000	.212
TOD	5.	3731.	564.561	11.283	27.147	395.144	500.000	488.350	.700
TRW	4.	3452.	1336.000	48.100	60.050	888.450	701.000	284.100	.665
TRW	1.	3662.	2754.000	92.500	196.900	1248.850	2772.000	1986.700	.453
TRW	2.	3714.	1687.500	61.350	56.800	987.500	.000	11.750	.585
TXN	4.	3471.	163.000	10.000	8.000	94.500	.000	.000	.580
TXN	3.	3662.	1298.000	75.000	154.500	571.000	.000	843.500	.440
TXN	2.	3681.	1069.500	44.500	17.500	517.500	.000	.000	.484
TXT	13.	3321.	331.500	8.500	5.000	121.000	62.000	.000	.365
TXT	9.	3524.	369.000	9.000	9.000	165.500	.000	.000	.449
TXT	11.	3541.	404.500	13.000	13.000	304.000	152.500	.000	.752
TXT	12.	3546.	462.500	8.000	12.500	216.000	68.500	.000	.467
TXT	5.	3721.	719.000	13.500	23.500	616.000	.000	.000	.857
TXT	8.	3764.	393.500	7.500	9.000	178.000	.000	.000	.452
TXT	10.	3910.	420.500	6.000	12.000	228.500	.000	.000	.543
UTX	8.	3714.	3428.848	109.538	210.399	2366.150	667.500	.000	.690
UTX	6.	3721.	2513.141	48.860	120.752	1205.496	2392.000	.000	.480

SMBL	SID	SIC	SALES	DEPREC	CAPX	ASSET	BLG	GSL	COR
WX	7.	3610.	3519.800	85.000	114.000	1824.150	973.500	.000	.518
WX	8.	3822.	1743.450	29.000	69.500	913.500	597.500	.000	.524

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